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Sustainable Development through Green Infrastructure: A Critical Evaluation of the Greater New Orleans Urban Water Plan

A Thesis

Submitted to the Graduate Faculty of the
University of New Orleans
in partial fulfillment of the
requirements for the degree of

Master of Urban and Regional Planning

by

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Bachelor of Arts in Political Science and International Studies,
University of North Carolina at Chapel Hill, 2005

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Finally, this thesis is dedicated to my husband and biggest supporter, Christopher Porter. Thank you for pushing me to be a better student, writer and person… and for loving me even when our living room was filled with books about stormwater management.

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Abstract

Sustainable development is achieved through the equal promotion of environmental protection, economic development and social equity. Urban planners play a key role in sustainable development through the mediation of tensions inherent between these priorities. Using urban planning theory that focuses on the conflicts between the priorities of sustainable development and lessons learned from planning practice provides a basis from which to evaluate the claims of sustainability present in the Greater New Orleans Urban Water Plan. Outreach initiatives, policy frameworks and ecosystem co-management are suggested to make the planning and implementation processes of the Greater New Orleans Urban Water Plan more feasible in terms of its ability to foster sustainability. Additionally, conceptualizing integrated stormwater management for Greater New Orleans within the context of the Louisiana coastal crisis can help to make the goals of the Urban Water Plan more realistic in the long term and boost institutional capacity to promote regional resilience.

KEYWORDS: Environmental Planning, Land Use Planning, Hazard Mitigation Planning, Sustainable Development, Greater New Orleans Urban Water Plan, Integrated Stormwater Management, Green Infrastructure, Public-Private Partnerships, Co-Management, Participatory Planning, Resilience Planning

Chapter I

Introduction

In October 2013, the Greater New Orleans Urban Water Plan was released to the public. The stormwater management plan proposed to revolutionize the traditional drainage and pumping system of the region by following the Dutch model of stormwater management that promotes slowing the movement of stormwater, storing it where it falls, and using it as appropriate. The plan was created by Waggonner & Ball Architects, along with input from consultant firms from the Netherlands and the New Orleans region. Funding for the water management study and subsequent creation of the Greater New Orleans Water Plan was provided by regional economic development organization, GNO, Inc. following an infusion of federal grant money (Waggonner & Ball, 2013a). The grant was given to assist the Greater New Orleans region, defined as Orleans, Jefferson and St. Bernard Parishes, in preventing future damage from flooding and has thus been promoted by GNO, Inc. and Waggonner & Ball Architects as a means to achieve regional sustainability (Waggonner & Ball, 2013). Because sustainability in the Greater New Orleans region has been stated by the plan's creators and promoters as a driver of the planning process that culminated in the Urban Water Plan, an analysis of the ways in which the plan has balanced environmental management, economic development and social equity in its design, and throughout the overall planning process, is appropriate prior to implementation (Campbell, 2012).

The planning process of the Greater New Orleans Urban Water Plan focused largely upon the design of green infrastructural improvements to the physical environment. This focus, as claimed within the plan, was necessary because an enhanced urban environment will increase the region's potential for economic growth, and thus increase the quality of life for the region's inhabitants (Waggonner & Ball, 2013a). I will argue in this thesis that the strong focus placed on urban design in the planning process and plan itself, may not lead to overall sustainability in the area because it has limited the role that citizens play in plans affecting their communities, and has also led to a limited prescription of how to

foster economic development in the area. Instead of seeing equitable development as an integral part of the planning process and the plan document, the plan's emphasis on urban design has relegated this crucial component of planning for sustainability to a mere outcome of urban design.

The fact that the Greater New Orleans Urban Water Plan has yet to be fully funded and implemented provides a critical opportunity to evaluate the planning process and improve the plan's ability to promote sustainability in the future. Therefore, this thesis will provide a critical evaluation of the Urban Water Plan in its potential to foster sustainable stormwater management. Through analyzing the plan in terms of its potential to protect water-based ecosystems, foster economic development and include citizen interests in decision-making, I hope to provide a constructive critique that will encourage improvement of the plan prior to implementation. The critique will form the basis for my hypothesis that best practices and theory from the urban planning profession, when applied to the Urban Water Plan's attempts to stimulate sustainability, will lead to a better version of the document, and ultimately to better implementation.

Additionally, this thesis will take a hard look at the Urban Water Plan as it corresponds to the broader context of coastal resilience in southern Louisiana. The region for which the stormwater management plan is designed is enclosed by infrastructure that provides a buffer from the effects of storm surge from hurricanes, and yet it also serves to effectively close off much of the region from the coast that surrounds it. Greater New Orleans is a city along the coast of the Gulf of Mexico. Pumping large amounts of funding into green stormwater management to increase urban sustainability is a futile exercise if the coastal geography of the region is not taken into broader context. Therefore, this thesis will highlight ways in which the Greater New Orleans Urban Water Plan links the severe issues of coastal land loss and sea level rise to local stormwater sustainability.

Purpose of the Study

This thesis is intended to critically evaluate the Greater New Orleans Urban Water Plan in its claims of sustainability. More specifically, best practices from the urban planning discipline will be suggested for the purpose of improving the plan and its implementation. Thus, the thesis will promote a theoretical basis from which to evaluate a local response to the challenge of sustainability through stormwater management (Tang et al., 2011). Conducting the analysis in this way allows for what Beatley states will encourage well-rounded, "holistic thinking" throughout implementation (2009). Due to the perilous position of the Greater New Orleans region to the changing Gulf coast, I will use this sustainability evaluation to more broadly discuss coastal resilience in the context of climate change. I hope that the inclusion of resilience in this discussion will highlight the areas in which more research on strengthening regional connectivity and institutional capacity are necessary in order to implement truly sustainable stormwater management.

This thesis relates to research on planning procedure, sustainable development integrated stormwater management, and resilience planning. Much work has been done in planning literature on the creation of just, prosperous and green city plans, and this thesis will apply such a theoretical basis to the practical context of stormwater management in Greater New Orleans. Many tensions are theoretically and practically inherent in sustainable development, and thus an examination of the Urban Water Plan through frameworks from urban planning that can help moderate such tensions will make sustainability easier to achieve regionally. Taking into consideration the larger issues of climate change on the coastal region will provide a means of moving away from literature that focuses on planning in isolation of the regional context to the theory that focuses on a more comprehensive, resilient way forward for coastal communities (Beatley, 2009). Therefore, the research questions guiding this study were as follows: (1) Does the Greater New Orleans Urban Water Plan promote sustainability? (2) What lessons learned from planning literature and practice could be utilized to improve the potential for the

plan to facilitate sustainability in the Greater New Orleans region? (3) How could a focus on regional resilience in the plan improve sustainability in greater New Orleans, and the Louisiana coast?

Chapter II will introduce the literature identified as relevant to sustainable development, stormwater management and resilience, and will therefore form the theoretical basis of the study. Chapter III will explain the methodology that guided the study in its attempt to explore the research questions. It will describe the evaluative technique used to judge sustainability in process and in the Urban Water Plan document. Chapter IV will summarize the Greater New Orleans Water Plan.

Chapter V assesses the plan's claims of sustainability. The potential to effectively protect water-based ecosystems through green infrastructure, create economic opportunities within sustainable stormwater management, and encourage representative and equitable decision-making will be evaluated as crucial components of overall sustainability in the plan. In Chapter VI, the thesis will suggest ways in which to strengthen the priorities of sustainability in the plan and planning process. Chapter VII will discuss resilience as a pathway towards overall sustainability, and highlight the ways in which the Urban Water Plan attempts to incorporate resiliency planning into stormwater management. Finally, in Chapter VIII, recommendations based in planning literature and the study's findings will be summarized to guide future research and plan implementation. A discussion of the research will follow, and a conclusion will end the thesis.

Chapter II

Introduction to the Literature Review

The literature review conducted for this thesis attempts to provide the basis from which to adequately resolve the research questions posed, and provide rationale for my contention that lessons from planning literature and practice, when applied to the Urban Water Plan's sustainability components of environmental protection, economic development and social equity, will lead to a more holistic version of the document, and ultimately to more sustainable implementation. A summary of the concept of sustainable development and its application in urban planning will begin this literature review. It is important to note at the onset of this chapter that literature regarding sustainability and sustainable development is vast, and thus to apply it in this analysis the research that will be reviewed in the paragraphs that follow has been tailored to the context of the Urban Water Plan in Greater New Orleans. Thus, the information regarding sustainability that follows focuses on specific issues within environmental protection, economic development and social equity pertinent to stormwater management. These sections will also highlight research about stormwater management that exemplifies ways in which to ease the tensions of sustainable development. By organizing the literature review in this way I have attempted to demonstrate the deep understanding of the value systems that underlie the priorities of sustainable development that is necessary in planning. It is hoped that by stressing collaborative endeavors that ease the conflicts of sustainability, this thesis will show support for the careful negotiation between priorities that planners can facilitate in order to operationalize sustainability.

Following a review of research related to sustainable development through water management, an integration of theory regarding external factors that affect local sustainability will be included in this chapter. Research that focuses on resilience planning will be highlighted in order to emphasize the

concept of regional resilience as a pathway towards easing the challenges of local sustainable development.

The Sustainability Concept

The analysis of this study is derived from the theoretical balance that can be achieved by planning for the three "E's" of sustainable development: environment, economics and equity (Berke, 2002). The concept of sustainable development was first identified by the World Commission on Environment and Development in the report *Our Common Future* in 1987. Sustainable development, as defined in the report, is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). Inherent in this definition are the concepts of "needs" and "limitations," in that sustainability is manifest in the adequate provision for the needs of society now and in the future, and is achieved by decision-makers through the negotiation of limits on the use of the environment, provisions for equitable development and continuous economic growth (WCED, 1987). For urban planners as decision-makers, the pursuit of sustainability can be a powerful "organizing principle" driving the process of the profession (Campbell, 2012).

Scott Campbell refers to the process of supporting sustainability in planning as "the planner's triangle" because it attempts to achieve three simultaneous goals that have divergent tensions among them (Figure 1) (Campbell, 2012). The three "E's" (environment, economics and equity) that formulate the points of the planning triangle represent values that have independently guided planning throughout its history (Berke, 2002; Campbell, 2012). Campbell suggests that as planners make decisions to balance the three values to promote sustainability, conflicts arise regarding the use of property, the scarcity of resources and the terms of development (Campbell, 2012).

The property conflict of the planner's triangle is derived from "competing claims on and uses of property" that can manifest in disagreement between landlords and their tenants, business and workers, and between longtime residents of a place and newcomers perceived as gentrifiers (Campbell,

2012). This conflict is difficult for planners to navigate because property owners in capitalist systems have traditionally valued their right to use private property as a commodity over any government regulation of that use (Campbell, 2012). Yet at the same time, government intervention into the use of private property is commonly justified by the guarantee that such intervention will allow property to provide the most benefit possible to society (Campbell, 2012). Thus, planners in their work to navigate this conflict must think about property in both its utility to private interests and the good of society.

Regulation on the use of the environment for conservation or for continued economic growth defines the resource conflict of sustainable development (Campbell, 2012). Private interest in capitalist systems has resisted government regulation of natural areas just as strongly as it has resisted such regulation on private property. In order to grow capitalist, industrial economies, anthropogenic use of the environment has been deemed a necessary practice. Yet, unbridled use of natural resources necessitates governmental intervention as natural resources are finite. In order for planners to ensure continued economic growth, regulations on the use of natural resources must be implemented (Campbell, 2012). Therefore, the contested utility of the environment as the source of natural resources and economic growth becomes one of the greatest conflicts that urban planners must negotiate due to the mutually dependent forces of environmental protection and extraction (Campbell, 2012).

The final conflict of sustainable development is perhaps the most difficult for planners to define and thus mediate. The development conflict arises when there is equal desire in society to both provide for adequate economic opportunity for all citizens as well as protect the natural environment (Campbell, 2012). Though similar to the resource conflict, the development conflict is concerned with simultaneously providing for equitable economic opportunity for all citizens and protecting the natural environment. The urban planner's role in easing this conflict lies in the professional understanding that environmental protection is not just a luxury for the wealthy, it is instead something that is valued by all citizens either through access to the natural environment, or in the distribution of resources derived

from it (Campbell, 2012). Planners must ensure that projects implemented to preserve the environment do not also lead to inequality in poor, urban communities (Campbell, 2012). Therefore, increasing citizen access to the decision-making process regarding the use and distribution of natural resources is the way in which urban planners can negotiate compromise in this conflict of sustainable development (Arnstein, 1969).

These inherent tensions between planning priorities have made the concept of sustainable development difficult to put into practice, but as Campbell further points out, the nature of the "conflicts is mutual dependence based not on opposition but also on collaboration" (2012). Thus, the challenge for planners in promotion of sustainable development is to recognize the opportunities available for compromise when balancing priorities. Pursing compromise in the planning process is to facilitate sustainable development through complementary (as opposed to conflicting) uses of nature within the urban context that acknowledges the value systems from which the three E's are derived (Campbell, 2012).

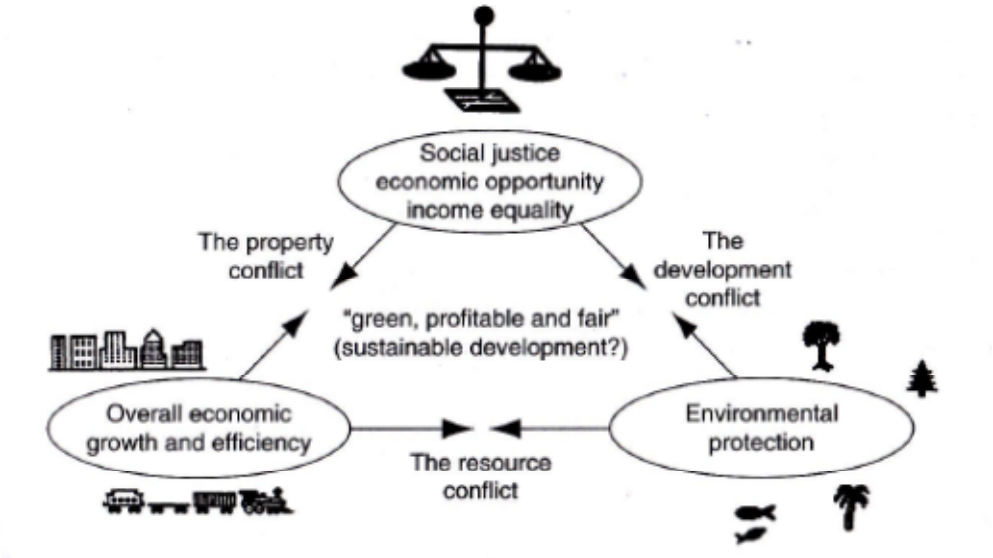

Figure 1: The Planner's Triangle (Campbell, 2012)

Sustainable Stormwater Management

In sustainable stormwater management, much attention has been traditionally placed upon the design and engineering of systems for adequate urban drainage, yet because stormwater and its infrastructure affects communities through their built environment, it is increasingly recognized in the field of engineering that a multi-disciplinary, integrative approach to planning for stormwater infrastructure is invaluable to the implementation of drainage technology (Barbosa et al., 2012). Rauch summarizes sustainable development in this context as the process of working towards solutions that adequately meet the water management needs of society and that add benefit to the urban environment (2013). Implicit in this definition are the familiar concepts of "needs" and "limitations" valued in sustainable development as described by the World Commission on Environment and Development (1987). The recognition of the need for a multidisciplinary approach to infrastructure provision, and the application of sustainable development concepts to stormwater management provide justification for the inclusion of urban planners in the process of designing for urban stormwater systems (Barbosa et al., 2012). Therefore, the following literature will limit the focus on sustainability in urban planning to the evolution of the planner's role in fostering sustainable stormwater management. Accordingly, sustainable development in this thesis will be focused on water resource-specific definitions of the three priorities of planning described by Campbell (2012).

For the purposes of this analysis on sustainable stormwater management, the priority of environmental protection in planning will be conceptualized by healthy, functioning ecosystems within a watershed. The economic priority in planning for sustainable water management differs only slightly from its traditional definition in that the continued and increased attraction of private investment to a location remains paramount, yet in terms of water management this investment attraction must be related to the economic opportunities that green infrastructure can provide (Leigh & Blakely, 2013). Finally, the concept of sustainable stormwater management focuses on the priority of social equity as

equitable inclusion in the decision-making process of planning for stormwater infrastructure by citizens in urban communities (Starkl & Brunner, 2004). Redefining the priorities of sustainability in this way helps urban planners working in water management to better understand the values at the heart of each priority, and thus facilitates negotiation between private interest and the public good in relationship to stormwater management.

Planners must negotiate compromises in sustainable stormwater management in order to work with the inherent conflicts that the priorities of sustainability create. Regulations implemented by urban planners in order to protect crucial water-based ecosystems may infringe upon the use of private property in proximity to the resource (Campbell, 2012). Urban planners must take this conflict into account when planning for green infrastructure in stormwater management, and can ease this conflict by promoting the benefits that vital ecosystem services can provide property owners in regards to water-related hazards (Schwab, 2010). The resource conflict of sustainable stormwater management arises from regulations on the amount of impervious cover that developers can construct to efficiently support business in urban environments. Regulations are increasingly put into place on impervious cover because it contributes to polluting stormwater runoff that destroys ecosystems. Private businesses may traditionally resist regulations on their use of the environment through regulations on impervious cover, yet planners can negotiate this conflict with the development of financial incentives for green infrastructure implementation that allow businesses to continue to operate in a cost-efficient way, and the creation of policies that engage the private market in green infrastructure for economic growth (Starkl & Brunner, 2004). Finally, the development conflict of sustainable stormwater development arises when the implementation of green infrastructure negatively affects the distribution of resources among citizens. Planners working to promote sustainable stormwater infrastructure development must ensure that the public is given equal opportunity to participate in the planning and management process for green infrastructure, and that any socioeconomic opportunity that is

stimulated by a greened environment provides equal opportunity for all citizens to benefit (Forester, 2008; Campbell, 2012).

With these priorities and conflicts defined, urban planners can work with landscape architects, engineers, technicians, communities and all others involved in water management in a collaborative process that results in healthy ecosystem buffers, innovative economic development opportunities, and balanced neighborhood decision-making processes regarding urban infrastructure (Berke, 2002; Portney, 2003).

The Environmental Priority: Protecting Water-Based Ecosystems

In the context of planning literature regarding urban stormwater management, the environmental priority for sustainability is realized through the preservation of ecological systems within watersheds (Berke et al., 2006; Roy et al., 2008). A watershed is "the area of land where all of the water that falls in it and drains off of it goes into the same place" and can refer to areas of varying size (USGS, 2014; Roy et al., 2008). Watersheds are home to diverse water-based resources that provide vital services to communities through their natural beauty, ability to mitigate hazards, and access for the public to the environment (USGS, 2014).

Berke et al. explain that urban planners can support overall watershed protection through the use of non-structural hazard mitigation tools that regulate of the amount of impervious cover in urban development that contributes to stormwater runoff that pollutes water-based ecosystems (2006). Schwab specifies that the non-structural tools of urban planning are land classification techniques that direct future development away from natural areas with known hazards, strengthen existing development to withstand hazard events, and that prevent known hazards from affecting existing development without the use of structural projects such as levees or floodwalls (2010). Non-structural hazard mitigation regulations for areas within watersheds are important tools utilized by urban planners

to preserve crucial ecosystems that provide many benefits to society from their beauty and valuable services (Roy et al., 2008; Carter & Fowler, 2007).

As stated by Schwab, non-structural hazard mitigation tools are the strongest instruments in use by urban planners to divert development away from areas within watersheds with important ecosystems needing preservation, and thus such tools must be used in a multi-disciplinary approach to sustainable stormwater management (2010). Berke et al. explain that land use classification techniques can be used to protect ecosystem health in that they help urban planners better understand the relationship between stormwater runoff and ecosystem vitality (2006). In order to preserve ecosystems in watersheds, urban planners need to determine the amount of impervious cover located within the watershed. Using the non-structural planning tool of land use classifications to determine the total surface area of development within each zone of a municipality, planners can then multiply each zone's total area by an associated percentage of impervious cover (2006). The value derived from this technique allows urban planners to easily understand how much stormwater runoff flows out of an urban area and into surrounding ecosystems (Berke et al., 2006). Using this technique, urban planners provide municipalities with a clearer picture of the health of a region's water resources that can influence the design of a sustainable stormwater system (Berke et al., 2006). Understanding the relationship of impervious cover and stormwater runoff to ecosystem health assists planners in the development of zoning ordinances, building and subdivision codes and other land use regulations for the benefit of the environment.

Once a basic understanding of the amount of stormwater runoff from urban development has been achieved, urban planning theory encourages the use of this information to preserve ecosystem functions crucial to sustainable stormwater management through the comprehensive planning process (Schwab, 2010). The amount of impervious cover and stormwater runoff in an area are crucial considerations of urban planners working to protect the environment through the creation of zoning

regulations and subdivision codes for municipalities. Each of these vital municipal tools can be used to preserve open space from development and thus keep ecosystems within a watershed safe from stormwater runoff (Schwab, 2010). Zoning and subdivision code elements that can be used to prevent development in open space and thus aid in the reduction of stormwater runoff in watersheds are: land use regulations, setback guidelines and overlay zone specifications (Schwab, 2010). Land use regulations can explicitly prevent development in open space and therefore preserve ecosystem functions. Setback guidelines can be used to reduce the amount of stormwater entering ecosystems by guiding development away from a waterfront, so that a buffer is formed between development and the environment (Freitag et al., 2009). Overlay zones are useful because they can be implemented by municipalities creatively and in response to specific issues of importance for communities such as environmental protection (Schwab, 2010). As opposed to traditional zoning techniques designed to explicitly restrict uses in urban areas, overlay zones can be designed as flexible zoning regulations implemented in response to important and timely issues facing the municipality (Schwab, 2010). Should urban planners, through the estimation of impervious cover within a watershed described above, find that stormwater runoff is detrimental to an area's watershed ecosystems, they can easily recommend the implementation of overlay zones to conserve open space for vital ecosystem functioning (LRAP, 2013).

Capital improvement programs, subdivision and building codes are additional ways to prevent stormwater runoff (Schwab, 2010). Strengthening existing development for the betterment of the environment involves the integration of green infrastructure design into new and existing development through capital improvement programs, subdivision and building codes by urban planners (Schwab, 2010). Incorporating the use of green infrastructure (such as bioswales, rain gardens, or rain barrels) for stormwater retention into municipal codes and capital improvements allows urban planners to prevent runoff from affecting the environment and existing development (Schwab, 2010). Green infrastructure

is important to the general health of water-based ecosystems because it allows rainwater to be stored in place and filtered into the ecosystem through constructed catchment systems, instead of allowing the stormwater to turn into damaging, polluted runoff (Bitting & Kloss, 2008). Research and practice show that in performing these vital functions, green infrastructure effectively acts to "mimic predevelopment hydrology" because it works to reduce the amount of runoff possible from development through the functioning of constructed water-based ecosystems (Williams & Wise, 2009).

Williams and Wise state that through the incorporation of green infrastructure design mandates by urban planners into municipal codes and capital improvement programs, urban planners can promote an integrated, holistic stormwater system drastically different than that created by conventional infrastructure such as drains and pumps (2009). Green infrastructure (also referred to as low impact development, or LID) designs make it so that rainwater flows towards open space that acts as "green" pervious areas as opposed to traditional "gray" storm drains for pumping and expensive treatment (Williams & Wise, 2009; Burns et al., 2012). Manmade green infrastructure designs that can be encouraged by nonstructural planning tools are bioswales, bioretention rain gardens, water-storing planter boxes, permeable pavement, green roofs, tree planting, downspout disconnections and cisterns. Research shows that each of these design features are important to the protection of ecosystems within the watershed because they help to infiltrate and evapotranspirate rainwater before it turns into stormwater runoff and causes pollution and degradation (Burns et al., 2012; Williams & Wise, 2009). For example, building codes can regulate the design of clearing and grading in new development so to direct the flow of rainwater to these pervious areas (Williams & Wise, 2009). Similarly, regulating the use of curb cuts and downspouts disconnections in the subdivision code aids in the flow of rainwater toward green, pervious infrastructure (Valderrama et al., 2013). Therefore, through the use of non-structural tools, urban planners can integrate a necessary regulatory framework into stormwater management that supports healthy water-based ecosystems.

Case Study: Non-Structural Regulation in Portland

A primary example of a multidisciplinary approach to sustainable stormwater management has been implemented in Portland, Oregon. The City of Portland, through its Bureau of Environmental Services Grey to Green (G2G) Initiative, has significantly reduced the amount of stormwater pollutants entering the area's watershed through the utilization of the regulatory tools of planning (2010). More specifically, through the use of regulation and incentives the city has encouraged the implementation of ecoroofs, green streets, tree planting, invasive species removal, re-vegetation, culvert removal, open space preservation and ecosystem restoration in natural areas to significantly impact the overall ability for the watershed's ecosystems to store rainfall and prevent flooding (City of Portland, 2010). A stormwater runoff retention standard was placed into the city's building code that applies to both new and redevelopment projects covering 500 square feet or more to reduce the amount of impervious cover in the watershed caused by development (NRDC, 2011). Portland has also created a municipal retrofit program with standards for the design of green city streets and green roofs on public buildings (NRDC, 2011). This retrofit program has been regulated by the municipal Public Facilities Plan implemented in 2011 that oversees capital improvements to municipal infrastructure, and is thus a non-structural planning tool (NRDC, 2011). Additionally, Portland encourages green infrastructure in new city facilities through its Green Building Policy, a stipulation within the building code requiring all publicly funded buildings to have at least 70 percent of the roof covered in green, impervious material (NRDC, 2011).

Permits for new development in Portland regulate green infrastructure techniques into construction design through a site stormwater retention standard in the building code. This standard requires that stormwater runoff be considered in the development of new projects, barriers to the implementation of green infrastructure be identified and mitigated, and that a strict guide to sustainable stormwater management be followed during construction (NRDC, 2011).

By focusing on integrating non-structural planning tools with the engineering of green stormwater design, Portland has created a more vibrant urban stormwater system that has had positive human and environmental health effects for the watershed environment as a whole. Green roofs implemented in the G2G initiative retain and evapotranspirate 55 percent of Portland's total rainfall annually, reducing pollution from stormwater runoff and helping to create healthier communities (City of Portland, 2010). Taking into account the nearly 11 acres of space that green roofs constructed for the G2G initiative cover citywide, these green infrastructural improvements reduce 552,600 gallons of stormwater per acre each year (City of Portland, 2010). In addition to the stormwater runoff mitigated by ecoroofs, Portland's addition of green infrastructure to its streetscape has culminated in a 90 percent reduction of stormwater runoff from impervious street area, or a decrease of 74,700 gallons annually (City of Portland, 2010). Trees planted as components of the ecosystem infrastructure implemented each mitigate 572 gallons per year of stormwater before it can fall to the ground and become runoff (City of Portland, 2010). The regulation of green infrastructure in new development and urban retrofits through non-structural urban planning has had a strong impact on the overall health of the watershed within which Portland is located. Mimicking the natural processes of water-based ecosystem services through green infrastructure improvements, Portland has moved from costly gray, aging stormwater infrastructure with negative impacts on the environment to holistic, green infrastructure that works to improve the quality of its water systems, air, land resources and overall quality of life for citizens.

By regulating the preservation of open space and the implementation of green infrastructural design to reduce stormwater runoff as has been done in Portland, Oregon, municipalities working with non-structural mitigation tools integrate the tools and best practices of planning into technical stormwater design. Doing so allows for necessary linkage between urban design and comprehensive planning, and supports the planner's role in promoting the environmental priority of sustainable development.

Easing the Property Conflict in Sustainable Stormwater Management

In protecting water-based ecosystems with conservation and green infrastructure, planners can attempt to ease the tensions of sustainable development by lessening water and air pollution in urban communities, mitigating the cost of stormwater flood damage to the built environment, as well as providing public access to water features. Yet, tensions still arise in the promotion of healthy watersheds because the regulations described above restrict the use of property by private interests (Campbell, 2012). One way that planners can mitigate this tension is through public education regarding the benefits that healthy ecosystem services can provide to support economic interests.

Costanza et al. define ecosystem services as "benefits human populations derive, directly or indirectly, from ecosystem functions" (1997). Ecosystem functions are interdependent and dynamic, yet these functions work together to support overall human welfare (Costanza, 1997). It is further emphasized in environmental planning literature that stormwater infrastructure projects that assist ecosystems in their natural functions of regulating climate and the occurrence of natural disturbances have immediate effects on an urban area's ability to withstand water-related hazards like flooding (Costanza, 1997; Freitag et al., 2009). Similarly, stormwater infrastructure that allows ecosystems to naturally regulate the flow and storage of an area's water resources help to reduce flood potential from stormwater runoff within communities, contribute to vibrant ecoystems, and recharge essential groundwater (Barbosa et al., 2012; Costanza et al., 1997). Additionally, the amount of runoff reduced by sustainable infrastructure within a watershed helps stabilize soils and filter pollutants from the water supply and thus safeguard water quality and ground stability (Barbosa et al., 2012; Costanza et al., 1997). As Costanza et al. prove in their analysis of the services they provide, working water ecosystems contribute to economic savings by mitigating damage from flooding and unstable soils. On a broader economic scale, healthy ecosystems and a vibrant environment promote a higher quality of life that can

be attractive to investment. A more extensive summary of the ecosystem services relevant to stormwater management, as described by Costanza et al., are outlined in Table 1 below (1997).

Table 1: Ecosystem Services and Functions Relevant to Urban Stormwater Management

Ecosystem Service	Ecosystem Functions	Examples
Climate Regulation	Regulation of global temperature, precipitation, and other biologically mediated climatic processes at global or local levels.	Greenhouse gas regulation, dimethylsulfoniopropionate production affecting cloud formation.
Disturbance Regulation	Capacitance, damping and integrity of ecosystem response to environmental fluctuations.	Storm protection, flood control, drought recovery and other aspects of habitat response to environmental variability mainly controlled by vegetation structure.
Water Regulation	Regulation of hydrological flows.	Provisioning of water for agricultural (such as irrigation) or industrial (such as milling) processes or transportation.
Water Supply	Storage and retention of water.	Provisioning of water by watersheds, reservoirs and aquifers.
Erosion control and Sediment Retention	Retention of soil within an ecosystem.	Prevention of loss of soil by wind, runoff, or other removal processes, storage of silt in lakes and wetlands.
Waste Treatment	Recovery of mobile nutrients and removal or breakdown of excess or xenic nutrients and compounds.	Waste treatment, pollution control, detoxification.
Recreation	Providing opportunities for recreational activities.	Eco-tourism, sport fishing, and other outdoor recreational activities.
Cultural	Providing opportunities for non-commercial uses.	Aesthetic, artistic, educational, spiritual, and/or scientific values of ecosystems.

Adapted from Constanza et al., 1997: 254

Table 1: Ecosystem Services and Functions Relevant to Urban Stormwater Management adapted from Costanza et al., 1997.

Whereas healthy, protected water-based ecosystems provide strong economic benefits, the pursuit of environmental protection must still be coordinated with the remaining two priorities of the planner's triangle as they relate to stormwater management (Campbell, 2012). Planners focusing on

environmental protection must work with economic development planners and communities to ensure that stormwater infrastructure is incorporated into these priorities so that sustainability can be ensured.

The Economic Priority: Promoting Growth with Sustainable Stormwater Management

As stated by Joan Fitzgerald and Nancey Green Leigh, economic priorities in urban development have traditionally had to do with directing private investment into a local economy in order to facilitate growth (2002). Economic planning theory has therefore traditionally suggested that planners work toward achieving this goal by making their communities favorable business environments for economic development through the use of financial incentives and weak regulatory policies (Leigh & Blakely, 2013). Whereas such practices may have helped business keep the costs of production low, the weakening of regulations regarding environmental standards have led to many negative externalities on the environment such as wetland degradation, air and water pollution and habitat loss (Cohen & Winn, 2007; Leigh & Blakely, 2013). In the context of stormwater infrastructure, water-based ecosystems have been negatively affected by anthropogenic economic activity through the amount of impervious cover constructed in watersheds to support industrial and commercial needs. This impervious cover has led to increased stormwater runoff that has damaged ecosystem functioning, inhibited their ability to perform vital services that benefit communities through reduced risk to externalities such as pollution and flooding, and have created a need for sustainable stormwater infrastructure to be implemented by municipalities in the future (Williams & Wise, 2009; Barbosa et al., 2012). Therefore, the economic priority of sustainable stormwater management focuses on sustained economic growth and the attraction of private investment to an area through the economic opportunity that green infrastructure implementation can create.

As Alisa Valderrama et al. point out, sustainable stormwater is a holistic endeavor and therefore must rely on the participation of the private sector in the construction of mitigation measures to supplement municipal stormwater infrastructure (2013). Encouraging the implementation of green

infrastructure on private property can be a difficult task due to private resistance to the costs associated with green design, construction and maintenance. Increased costs to homeowners and businesses can be a deterrent to the local economy if it affects consumer spending, the size of the tax base, and the cost of doing business. Taking this resistance into account, urban planners can encourage private mitigation measures to supplement municipal stormwater infrastructure through the creation of incentives for green infrastructure investment for private property owners that keep the cost of green infrastructure low (Valderrama et al., 2013). Such creative economic planning benefits private interests for economic stability, as well as the overall stormwater system. Where implemented, these initiatives have helped to encourage, fund and complete the infrastructural upgrades necessary to support more holistic, sustainable stormwater management systems in urban areas that benefit the environment and increase the attractiveness of areas for economic opportunity (Valderrama et al., 2013). The use of such initiatives by urban planners to encourage public-private cooperation in stormwater management exemplifies the role of the planner in promoting the priority of economic development, and in overall sustainable development.

Financial incentives to subsidize mitigation measures on private property have made green infrastructure more marketable and politically feasible (Shapiro, 2011). As opposed to government regulation, incentives are designed to give property owners a choice as to whether or not to implement green infrastructure. If property owners decide to implement green infrastructure to supplement the urban stormwater system, they can qualify for several types of municipal financial assistance that help homeowners save money, business continue to operate at best cost, and stimulate local economies (Shapiro, 2011). Therefore, the urban planner working to promote sustainable development has an obligation to balance municipal regulations for environmental protection with incentives for green infrastructure design for property owners.

Many governments creating a budget to update their stormwater infrastructure towards a greener, more sustainable system begin the process by increasing the municipal fees associated with sewerage and water utilities (EPA, 2009). For property owners, the increase in utility fees can significantly affect their household income and business profit margin, and thus ways to reduce this cost in the long run are amenable to many property owners and businesses (Valderrama et al., 2013). Urban planners can help ease the burden of increased fees on property owners by negotiating a reduction in fees for property owners should they prove to the municipality that they have significantly reduced the amount of impervious cover on their property through the implementation of green infrastructure design (EPA, 2009). The cost of constructing green infrastructure to remediate impervious cover is generally much less in the long run when compared to the cost of higher utilities fees, and is therefore an attractive option to private interests to keep long term costs low (Carter & Fowler, 2008).

Easing the Resource Conflict in Sustainable Stormwater Management

Leigh and Blakely point out that municipalities competing with other locations for private investment have traditionally been guided by "policies and programs [that] make their area more attractive to investors, firms, new migrants, entrepreneurs, and others" (2013). Such "attraction models" have been used in economic development to help communities gain a competitive advantage over others (Leigh & Blakely, 2013). Yet, as Leigh & Blakely argue, traditional location attraction models focused on the best place to do business regionally are increasingly outdated as cities begin to implement sustainable development in a globalized economy (2013). In order to mitigate the conflict that arises between traditional economic interests and environmental protection in sustainable development planning, urban planners are tasked with continuing to attract private investment while also promoting green infrastructure to protect the environment. By doing so, planners begin to focus on a more diverse set of urban attributes than have been traditionally considered in location attraction in order to stimulate economic opportunity and potentially mediate the resource tension through valuing

both the environmental and ecological utility inherent in sustainable stormwater management (Campbell, 2012).

One way planners have attempted to encourage private economic activity through green infrastructure is by the sale of sustainable stormwater credits on a private market (GNOF, 2013; Valderrama et al., 2013). Valderrama et al. theorize that urban planners can assist the creation of a private market through public policy recommendations to local and regional governments that would provide the regulatory environment necessary for private property owners to buy and sell stormwater credits. It has been further emphasized that such a market would benefit urban watersheds and attract coveted investment through green innovation (Valderrama et al., 2013). Valderrama et al. state that a private market for stormwater retention credits would be similar to a carbon offset market, where properties that exceed the requirements for stormwater retention can sell this excess capacity to developers that need assistance meeting minimum stormwater retention requirements (Valderrama et al., 2013). Such a private market has yet to become popular, but as research on how to implement it grows, it could become a powerful financial incentive to attract private commercial investment in extensive green infrastructure and increase the livability of a place (Valderrama et al., 2013).

Case Study: Private Markets for Green Infrastructure in Philadelphia

If communities want to implement sustainable stormwater management and continue to court economic investment, then a private market for green infrastructure could be fostered and used to encourage economic growth and ease the resource conflict. Incentives and regulations are essential for sustainable stormwater implementation, yet in order to gain the full support of private economic interests in the protection of healthy ecosystems from sustainable stormwater management, research has increasingly encouraged planners and municipalities to think creatively about the potential for private markets for green infrastructure. One public-private partnership for urban stormwater management that has been recommended for urban planners is the allowance and regulation of private

funding for public green infrastructure retrofits, also referred to as pay-for-performance financing (Valerramma et al., 2013). Such a policy framework has been suggested by Valderrama et al. for Philadelphia, PA in order for the city to implement green infrastructure on a large scale. To satisfy Clean Water Act requirements to regulate the amount of water pollution stemming from wastewater runoff, the city of Philadelphia has agreed to reduce the annual number of combined sewer overflow events over 25 years using green stormwater management beginning in 2010 (Valderrama et al., 2013). In order to achieve this, the city has endeavored to integrate green space and infrastructure into public areas through regulatory tools and incentives for private investment (Valderrama et al., 2013). Yet, as is the case in many US cities, the amount of green infrastructure development necessary to green the public and private space in the city and meet the requirements of the Clean Water Act is extensive, and thus the city has been exploring ways in which to encourage private funding of municipal green infrastructure retrofits (Valderrama et al., 2013). Whereas public-private partnerships have been used successfully in Philadelphia to fund transportation infrastructure, sewage and waste services and cogenerate electricity and heat for the city, the use of such capital for stormwater infrastructure has not yet been implemented. Therefore, Valderrama et al. suggest applying the planning frameworks and legislation in place to regulate current private funding for public infrastructure to guide their use in sustainable stormwater management (Valderrama et al., 2013). Utilizing public-private partnerships in this way would provide a strong example of how urban planners can encourage sustainability and mitigate the tension between economic and environmental interests in stormwater management with a private market for green infrastructure.

Valderrama et al. propose that engaging the private sector in public green infrastructure development in Philadelphia could be possible through the facilitation of private financing for infrastructure on public property such as schools, vacant lots, parks and other government- owned green space. In an attempt to potentially avoid the use of a primarily municipal bond-financing

approach to green stormwater infrastructure on public land, Valderrama et al. suggest that private funding following a public-private partnership methodology could prove useful for the scale of retrofitting needed to preserve the urban watershed of Philadelphia (2013). The method suggested by the authors to guide the process of private financing for public infrastructure is the availability payment model (Valderrama et al., 2013). Using this model for green infrastructure, Valderrama et al. suggest that municipalities such as Philadelphia could attract and contract with private engineering firms for the implementation of green stormwater projects on public property. The municipality would hire a private firm to "design, build, and maintain a specified number of greened acres" (Valderrama et al., 2013). Upon completion of the greened acres, the Public Works Department of Philadelphia would then make regular, contracted payments to the private developer for use of the infrastructure (Valderrama et al.). Valderrama et al. encourage the participation of urban planners in the negotiation of these contracts for public green infrastructure, so that the design of the infrastructure would benefit the city in its attempt to comply with the Clean Water Act regulations (Valderrama et al., 2013).

Using public-private funding partnerships like the one outlined for Philadelphia to create and retrofit green stormwater infrastructure could provide a creative and needed private market for large scale sustainability that would increase an area's attractiveness for investment and in-migration as well as ease the tension between regulation and profit-making, through the privatization of city services. In addition to the use of regulation and financial incentives to implement green urban infrastructure, the facilitation of a private market like the one suggested for Philadelphia would allow urban planners to maintain a local tax base among property owners and encourage a supportive business environment to attract future investment.

As reviewed in the sections above, urban planners can attempt to mitigate the tension between preserving healthy ecosystems and encouraging economic development in sustainable stormwater management through the use of traditional non-structural regulatory tools, municipal incentives and the

potential implementation of policies that create opportunities for private interests to profit from green infrastructure innovation. Doing so allows urban planners to make urban areas more attractive for investment and in-migration in a global economy. Supplementing the regulation of environmental protection and green infrastructure with local economic development tools promotes more politically feasible municipal infrastructure upgrades. Yet, in order to fully achieve sustainability in stormwater management, urban planners must develop ways through which to balance designs for environmental protection and strategies for economic investment and development with processes for social inclusion.

The Equity Priority: Inclusion and Distribution in Sustainable Stormwater Management

As stated by Campbell, the equity priority in sustainable development is realized by the fair distribution of opportunities, resources and services within urban areas (2012). Including citizen participation in planning can be time-consuming, yet it can result in the modification of plan goals and activities necessary for social justice, and therefore for sustainability (Forester, 2008). As extensive planning literature on the subject demonstrates, including community members in the planning process, and therefore giving voice to their value-based concerns, allows urban planners to ensure that projects affecting communities are politically palatable and designed to be representative of community need (Forester, 2008; Duxbury & Dickinson, 2007). In the context of stormwater management, urban planners have a critical role to play in developing the processes for social inclusion in the planning and development processes of sustainability. Using relevant theory on social equity to guide them, urban planners can attempt to broker the provision of community needs in terms of water-based resources, with those of healthy ecosystems and economic growth (Roy et al., 2008). Because sustainable stormwater management must be initiated at a municipal level in order to be comprehensive, the inclusion of urban planners in the planning process for development is suggested in literature to ensure that community members and stakeholder interests are a crucial component in the decisions made for a successful and politically feasible stormwater management system.

Inclusive processes for sustainable development must take place, and urban planners can play a critical role in facilitating them. Because the profession is informed by theory regarding community participation in process, planning provides best practices from which sustainability can be designed and implemented. Participatory planning, as described by Sherry R. Arnstein in *A Ladder of Citizen Participation*, is citizen empowerment realized through "the redistribution of power that enables the have-not citizens, presently excluded from the political and economic processes, to be deliberately included in the future" (1969). Arnstein further argues that such power-sharing can inform governance practices that distribute services, resources and opportunities among citizens, and that this governance can take place at varied levels ranging from non-participation to empowerment of citizens (1969). Arnstein describes the gradations of power between these extremes of social inclusion in the planning process as the "ladder of citizen participation", and suggests that this representation should be used to guide participatory decision-making processes. Using the ladder of participation as a guide for the urban planning process, Arnstein thus suggests that planners can facilitate an inclusionary process of mutual understanding and promote adequate distribution of resources and opportunity (Figure 2 below) (1969).

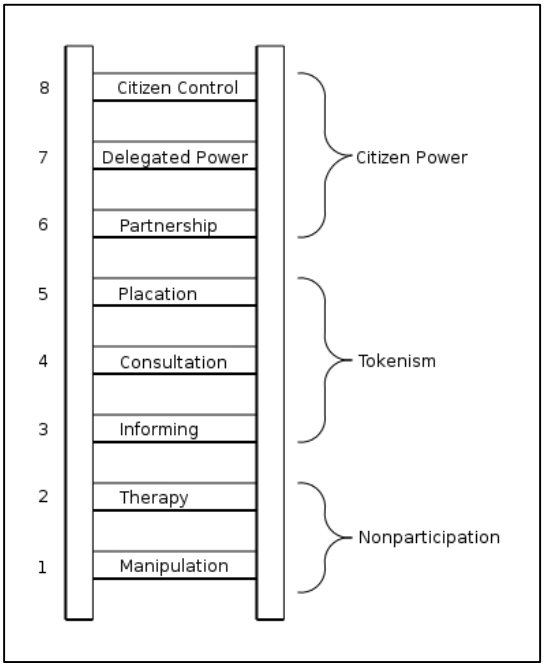

Figure 2: Ladder of Citizen Participation, (Arnstein, 1969)

Using Arnstein's ladder for participation to guide inclusive municipal planning can help planners and communities engage in a constructive process for sustainable stormwater infrastructure that allows for the equitable provision of citizen needs at the time of implementation and in the future (Forester 2008; OCED, 1987). Thus, urban planners who facilitate the inclusion of citizens in the process of planning for green infrastructure support practical evaluation of urban design and of projected outcomes (Bitting et al., 2008). Such a process can allow for the restructuring of stormwater management infrastructure plans so that they better represent community interests, needs and are more feasible in the long term.

Easing the Development Conflict in Sustainable Stormwater Management

The development conflict of sustainable stormwater management is derived from the difficulty in providing equitable opportunity for citizens while at the same time regulating the uses of the natural environment and using public incentives to facilitate private investment in municipal infrastructure (Campbell, 2012). This tension is comprised of two important issues that urban planners promoting sustainable stormwater infrastructure must consider. The first issue involves the participation of community members in the planning and design process for public green stormwater infrastructure regulated by municipal governments (Arnstein, 1969). Planners can mitigate this tension by developing ways in which community members can participate in the decision-making process for regulations that designate green infrastructure placement, design, implementation and management. Public participation in the planning and management of stormwater infrastructure will make implementation more representative of community need and politically feasible in the long term.

Watershed ecosystems within urban areas are complex and take significant effort to preserve and plan for (Roy et al., 2008). Thus, it has been suggested by Berkes that initiatives that "look beyond government, toward public-private-civil society partnerships" can be beneficial to achieving comprehensive watershed management (2009). It therefore follows that urban planners can facilitate a

more complete green stormwater system by supporting co-management linkages between government, private interests and citizens of water-based eco-system preservation (Roy et al., 2008; Duxbury & Dickinson, 2007; Berkes, 2009). Co-management of ecosystems exemplifies the application of participatory planning theory into sustainable stormwater management since the practice of co-management allows for citizens to exercise their power through inclusion in the design, planning, implementation and monitoring of green infrastructure development (Arnstein, 1969; Duxbury & Dickinson, 2007). In developing a co-management program for sustainable stormwater, planners help to disseminate information regarding municipal projects to communities and ensure that multiple viewpoints are built into municipal decision-making (Arnstein, 1969; Duxbury & Dickinson, 2007). The inclusion of different points of view from many community members can help to ensure that green infrastructure design proposed adequately protects the environment, and successfully provides safety for communities within the watershed from pollutants and risks to water-related hazards. Thus, co-management in planning for sustainable stormwater management makes the preservation of water-based ecosystems more holistic and feasible in the long term because it involves a dynamic, flexible, collaborative process that can adapt to the needs of both the communities and ecosystems of urban areas as the development process moves along (Berkes, 2009; Roy et al., 2008). Therefore, urban planners must seek out citizen inclusion in the process of planning for sustainable stormwater infrastructure in order to facilitate long-term, comprehensive protection of water-based ecosystems.

Coordinating co-management of ecosystem resources through participatory planning allows urban planners to support shared responsibility of the health of ecosystem services among community partners and respond to the resource needs of communities (Berkes, 2009; Roy et al., 2008). Directly involving citizens in the management of green infrastructure allows for decisions made regarding sustainable stormwater infrastructure in watersheds to be connected to the interests, values and livelihood promotion of all citizens within an urban area (Berkes, 2009; Webb et al., 2009). Urban

planners who support co-management can thus foster communication between communities, private interests, and different levels of government regarding the equitable distribution of water-based resources such as access to water features, and flooding mitigation technology (Berkes, 2009; Duxbury & Dickinson, 2007). Initiating communication about and processes for adequate resource distribution between traditionally competing interests in sustainable stormwater management is a valuable skill that trained urban planners can exercise through the use of participatory planning and co-management practice (Campbell, 2012; Berkes: 2009; Arnstein, 1969). Implementing participatory planning through co-management helps to develop an institutional dynamic among stakeholders in stormwater infrastructure that can encourage the equitable distribution of ecological resources in urban areas (Webb et al., 2009; Berkes, 2009).

The second issue that comes to the forefront in the development conflict has to do with equal opportunity for a good standard of living for citizens in urban areas that incentivize green infrastructure. Municipalities that incentivize and court private markets for green infrastructure implementation have a responsibility to ensure that any public funding given to private contractors or property owners to encourage sustainable stormwater management is used with integrity and results in social benefits to taxpayers (Bartik, 2007). Urban planners mitigate this issue through the development of performance standards into incentive programs and private contracts that ensure public money paid to private developers creates the comprehensive stormwater system required for social benefit, and equal opportunity for quality employment in green infrastructure construction and management is given to all community members (Bartik, 2007; Weber, 2007) .

Urban planners can promote equitable development through participatory planning in green infrastructure provision by working with communities to develop performance standards such as design requirements into municipal contracts for the private provision of stormwater systems (Valderrama et al., 2013; Bartik, 2007). Such requirements can ensure that municipal investment in green infrastructure

is beneficial to the drainage, safety and health needs of all citizens and that these benefits are distributed fairly among urban communities (Bartik, 2007). Urban planners have the ability to create guidelines for green infrastructure design that would benefit all citizens in an urban area, and by working with communities through collaborative co-management planners can ensure that these guidelines are followed during private infrastructure development (Berkes, 2009; Shapiro: 2011). Doing so would ensure comprehensive and fair implementation of green stormwater infrastructure resources.

In addition to the creation of design guidelines for a comprehensive green stormwater system, urban planners should work with communities to institute the use of performance standards specific to economic opportunity in municipal contracts for green infrastructure to ensure that public money used in private contracts produces adequate social benefit from green infrastructure (Weber, 2007; Bartik, 2007). Performance standards for equitable economic opportunity should be designed by participatory governance processes to ensure that green infrastructure project procurement considers local as well as regional or national firms for engineering and construction contracts (Valderrama et al., 2013; Weber, 2007).

Another performance standard suggested in the literature that could be initiated with community input to ensure opportunity is created for citizens with the use of public funds would be the development of a hiring stipulation in public contracts for infrastructure development. Such a provision would ensure that jobs created by green infrastructure construction went to local workers (Bartik, 2007; Weber, 2007). Additionally, economic planning research suggests that requirements that jobs created by green infrastructure projects for locals offer a quality wage rate could be developed as a performance standard with community input in the planning process (Weber, 2007). In this way, urban planners and the participatory process of planning can ensure that economic investment and opportunity generated through sustainable stormwater management benefits locals through job creation and an increased standard of living.

Case Study: Public Participation in Stormwater Planning in Philadelphia

The Philadelphia Water Department's Green City, Clean Waters program for sustainable stormwater management provides an example of how participatory planning in green infrastructure development can facilitate comprehensive watershed co-management (City of Philadelphia, 2009). Extensive public education and community outreach were conducted by the city and the watershed co-management team to get necessary feedback regarding citizen needs from resource management. This outreach has culminated in public awareness measures being prioritized in green infrastructure development in the city (City of Philadelphia, 2009). Relationships built and fostered over ten years of outreach helped the Water Department to ensure that the benefits experienced from green watershed management have contributed to healthier ecosystems, a safer environment for citizens and a better quality of life in communities within the city (City of Philadelphia, 2009).

The public-private governance approach to a healthy watershed was begun by the City of Philadelphia with the formation of an advisory committee to guide a collaborative goal setting process that reflected the interests and values shared by various stakeholders in regards to their environment within the city (2009). Public outreach and work conducted with the advisory committee for the Green City, Clean Waters program has culminated in community members developing programs to guide strategies for citizen communication and inclusion in green infrastructure development and management. From these strategies, public meetings have been held, coalitions within neighborhoods have been formed to support green infrastructure projects, and guidelines for small scale, household mitigation measures have been created to ease homeowner transition to green infrastructure such as the construction of rain barrels (City of Philadelphia, 2009). Through an active commitment to engage citizen participation through collaborative governance of the Philadelphia watershed, the city and urban planners have worked to mitigate the tensions inherent in planning for social equity in sustainable

stormwater development, and can thus serve as an example of the proper processes from which other cities can promote the benefits of green stormwater infrastructure in their communities.

As Grengs points out, the challenge to urban planners in promoting equity among the other priorities of sustainable development lies in the framing process of a project (2002). Because the priorities of sustainable development are traditionally at odds with one another, urban planners must facilitate the re-framing of these divisions towards a mutual agreement that it is within all priorities' interests to find a common solution that will benefit the health, safety and welfare of communities, local economies and urban environments (Forester, 2008). Urban planners, such as those in Philadelphia, promote equity in sustainable development through inclusion in the planning process because social inclusion helps direct communities and their governments away from "a problem –solving focus to a shared agreement" created by equal opportunities and the distribution of services and resources (Forester, 2008). Working to promote the commonality between the priorities of environmental protection, economic development and social equity through participatory planning allows planners to negotiate the flexibility and compromises essential for sustainable development.

Planning for Resilience: Sustainability Ensured

The planning and negotiation tools and strategies outlined in the literature review above, while they assist in easing the tensions between seemingly conflicting priorities in sustainable stormwater management, are ineffectual if the larger context within which an urban watershed is positioned is not taken into account. Planning for sustainable urban stormwater systems without considering geographical location, regional connectivity and the potential effects of climate change on watersheds is a meaningless endeavor as these external factors can strongly affect the long term viability of sustainable planning (Cumming, 2011).

Urban planning literature has therefore begun to conceptualize sustainable development as possible only as an effect of adequate planning for regional resilience (Laurian et al., 2004; Godschalk,

2003). Resilience planning is described in literature as a way in which to promote urban communities that can adaptively manage threats to their vital services and functions (Carpenter et al., 2001). Whereas much theory regarding planning for the priorities of sustainability provides specific, guided processes for development, resilience planning focuses on ideas of "networks, self-renewal and survival" (Stumpp, 2013). Instead of solely planning for each priority of sustainable development and working to broker negotiations between stakeholders, planning for resilience challenges planners to think about sustainability in a complex, regional context.

In relationship to urban stormwater management, planning for regional resilience fosters sustainability at the local level because the ability of a region within which an urban watershed is located to withstand disturbances has an effect on the ability of local green stormwater systems to function as intended (Jabareen, 2013). Urban stormwater infrastructure is very vulnerable to external changes from regional disturbances because, as Barbosa et al. point out, the "geophysical characteristics of [an] area will affect the quantity and quality of the stormwater" that runs into the system and surrounding environment. Therefore, a movement towards regional resilience planning has been posited in urban planning literature to help mitigate regional effects on urban infrastructure such as stormwater systems (Stumpp, 2013; Desouza & Flanery, 2013).

Planning that focuses on resilience thinking has been described by Walker and Salt as "an approach to appreciating what's driving and configuring the enterprise or organization that is of most interest" to ourselves, our communities and our environment (2006). Applying this approach to urban stormwater management, it becomes apparent that an understanding of the external processes driving the way in which ecosystems, economies and communities within urban environments function is necessary in sustainable infrastructure planning (Walker & Salt, 2006). Understanding the larger context within which the stormwater system is placed should push planners to build regional institutional

capacity, economic opportunity, and community networks so that what happens at a regional level does not cause socioeconomic and ecological devastation at a local level (Ffolloitt et al., 2003).

Therefore, urban planners are urged to facilitate collaboration among public, private and civil organizations in order to build regional capacity to adapt to disturbances to infrastructure caused by external factors such as climate change (Jabareen, 2013). Strengthened regional institutions should be guided by regional development policies that link the regional context to individual urban plans for sustainability (Duxbury & Dickinson, 2007). By working together to conceptualize overall resilience, urban planners and their regional communities work to understand the root causes of threats to sustainable development, and from that understanding they can develop incremental improvements to regional cooperation in hopes of healthier and more sustainable environments, economies, and communities (Wamsler, 2014). A commitment to resilience in order to foster sustainability must influence the design of the planning process for each priority outlined above, and thus must guide the development of urban growth and infrastructure development (Beatley, 2009).

Conclusion of Literature Review

The concept of sustainability in planning as described by Campbell and utilized in this literature review in regards to stormwater management provides the basis from which to analyze claims of sustainability made in the Greater New Orleans Urban Water Plan. Using the theoretical descriptions of the priorities of environmental protection, economic development and social equity outlined above, the ways in which the Urban Water Plan describes these priorities in its documents are more clearly identified. By focusing on strategies outlined in urban planning theory and practice to negotiate the tensions of sustainability, this literature review creates the foundation for recommendations made later in this thesis as to how to improve the Urban Water Plan prior to implementation. Additionally, research regarding resilience planning as a means of attaining sustainability as outlined above will be

used to identify efforts made in Urban Water Plan documents to include the ways that external, regional effects may factor into the feasibility of local stormwater infrastructure in the long term.

Chapter III

Methodology

The Greater New Orleans Urban Water Plan attempts to resolve the urgent need for an updated stormwater management system in the region. Maintaining and operating stormwater infrastructure in the three-parish area of the plan's focus is challenging due to the region's significant amount of annual rainfall, aging infrastructure, and its proximity to critical water sources. The Urban Water Plan proposes the implementation of green infrastructure to better contain and filter stormwater in the region. In addition to revolutionizing traditional stormwater management in Greater New Orleans, the Urban Water Plan also claims that green infrastructure will contribute to sustainable development in the region. Because the green infrastructure designs of the Urban Water Plan have yet to be implemented, constructive criticism of the plan and its process is appropriate to encourage improvement prior to any green infrastructure development in the study area.

The research conducted in this thesis to test the hypothesis that best practices from within the literature of urban planning should be applied to the Urban Water Plan to ensure that the plan is successful in promoting sustainability in the region followed an approach comprised of an exploratory, qualitative method. More specifically, this analysis included grounded theory research, content analysis of the Urban Water Plan's designs and process, and theory-based inference. To begin the study, a thorough exploration of the content of the Urban Water Plan as a whole was conducted (Krippendorff, 2004). As stated by Krippendorff, content analysis is an "empirically grounded method, exploratory in process, and predictive or inferential in intent" and therefore was used to fully understand the purpose, design and feasibility of the Urban Water Plan.

In exploring the plan's content, recurring themes related to sustainable development and resilience planning within the plan were identified that led to the exploration of urban planning theory and lessons learned from planning practice relevant to the emergent themes. Conducting the literature

review following the discovery of themes in the Urban Water Plan thus followed a grounded theory research methodology (Glaser and Strauss, 1967). As stated by Glaser and Strauss, a grounded theory approach begins with an "initial, systematic discovery of the theory from the data of social research" to ensure that the theory will fit with the data, which in this case are the sustainability and resilience elements of the Urban Water Plan. Thus, theory concerning sustainability and resiliency planning was studied in the literature review conducted for this research in order to ascertain whether or not the Urban Water Plan adhered to the key concepts of sustainability and resilience in planning.

As identified by the literature review conducted for this study and driven by the themes of the Urban Water Plan, the core responsibility of the planning process is to facilitate the negotiation of different values and goals among communities. Thus the research conducted for this study of the Greater New Orleans Urban Water Plan tests whether or not the plan could benefit from the expertise of the planning profession. The plan was created by Waggonner & Ball Architects with limited input from urban planning professionals and, though both the urban planning and architectural fields focus much of their professional attention on the built environment, the philosophies of each differ due to pedagogical differences. The instruction and practice of urban planning looks beyond issues focused purely on the physical attributes of a city, and instead is driven more strongly by process (Berke, 2002). Thus, urban planning literature and practice was reviewed as part of the grounded theory approach to the study due to the stated need for an integrated approach to infrastructure development supported by Barbosa et al. (2012). As Susan Fainstein points out, planning focuses not only on the built city environment, but examines:

> questions of who owns the city, not in the sense of direct individual control of an asset but in the collective sense of each group's ability to access employment and culture, to live in a decent home and suitable living environment, to obtain a satisfying education, to maintain personal security, and to participate in urban governance (2012).

Such a perspective justified the application of urban planning literature to the analysis of the Urban Water Plan in order to assist this analysis in determining the social and economic implications of urban stormwater design.

Passages in the Urban Water Plan's documents that made reference to specific elements of sustainability and resilience in planning were identified in order to answer the first research question posed by the study: Does the Greater New Orleans Urban Water Plan promote sustainability? As previously stated, the passages identified as related to sustainability in planning were identified using content analysis and grounded theory methodology and were analyzed using the concept of sustainability in planning put forth by Scott Campbell (2012; Krippendorff, 2004; Glaser & Strauss, 1967). As theorized by Campbell, plans claiming to promote sustainability must attempt to balance "three conflicting interests: to 'grow' the economy, distribute this growth fairly, and in the process not degrade the ecosystem" (2012). The research conducted for this study therefore identified priorities of economic development, environmental protection and social equity in the language discovered in the plan relating to sustainability in planning. The language regarding the priorities of sustainability inherent in the Urban Water Plan formed the basis for evaluative and inferential judgments made in this study regarding the plan's ability to truly foster sustainable development (Krippendorff, 2004).

The second and third research questions of this study attempt to break down and test the hypothesis that best practices and literature from urban planning should be applied to the Urban Water Plan to ensure that the plan is successful in promoting sustainability in the region. This exercise also followed the grounded theory approach to the review of the Urban Water Plan that led to the identification of claims to sustainability and resilience in the plan and the discovery of applicable urban planning theory (Glaser & Strauss, 1967; Krippendorff, 2004). Inference was again conducted to ascertain the strengths and weaknesses of the plan's claims of sustainability and resilience in planning and formed the basis from which recommendations as to plan improvements were made (Krippendorff,

2004). Through the evaluation of the Urban Water Plan's claims to sustainability and resilience with the use of grounded theory, content analysis, and inference, an improved process for the implementation of the Urban Water Plan is recommended as constructive criticism derived from the methodology of this research (Glaser & Strauss, 1967; Krippendorff, 2004).

Chapter IV

Introduction to the Greater New Orleans Urban Water Plan

The Greater New Orleans Urban Water Plan is an urban stormwater management plan that relies heavily upon the internal management of water through green infrastructure design to mitigate the risk of flooding in Orleans, Jefferson and St. Bernard Parishes in Louisiana. The plan was created at the end of a two year study conducted by Waggonner & Ball Architects, various consultant firms, and Dutch water management experts to develop an integrated approach to sustainable stormwater management in the Greater New Orleans watershed (Waggonner & Ball, 2013a). This study was funded by Greater New Orleans, Inc. (GNO, Inc.) through federal funds distributed by the State of Louisiana's Office of Community Development – Disaster Recovery Unit (Waggonner & Ball, 2013a).

The Urban Water Plan incorporates green infrastructure design based on the Dutch water management model of slowing, storing, using and draining stormwater only when absolutely necessary in order to lessen reliance on traditional gray infrastructure in stormwater management in Greater New Orleans (Figure 3 below) (Waggonner & Ball, 2013a). The cost estimate for the Urban Water Plan ranges from $2.9 to $6.2 billion, to be incurred over a 30-50 year period (Waggonner & Ball, 2013). The Urban Water Plan claims it will promote overall sustainability in the region through a healthier water-based urban environment that reduces stormwater runoff (Waggonner & Ball, 2013a). The plan asserts that this improved environment will effectively attract business and investment to the region as well as improve the overall quality of life for citizens in Greater New Orleans (Waggonner & Ball, 2013a).

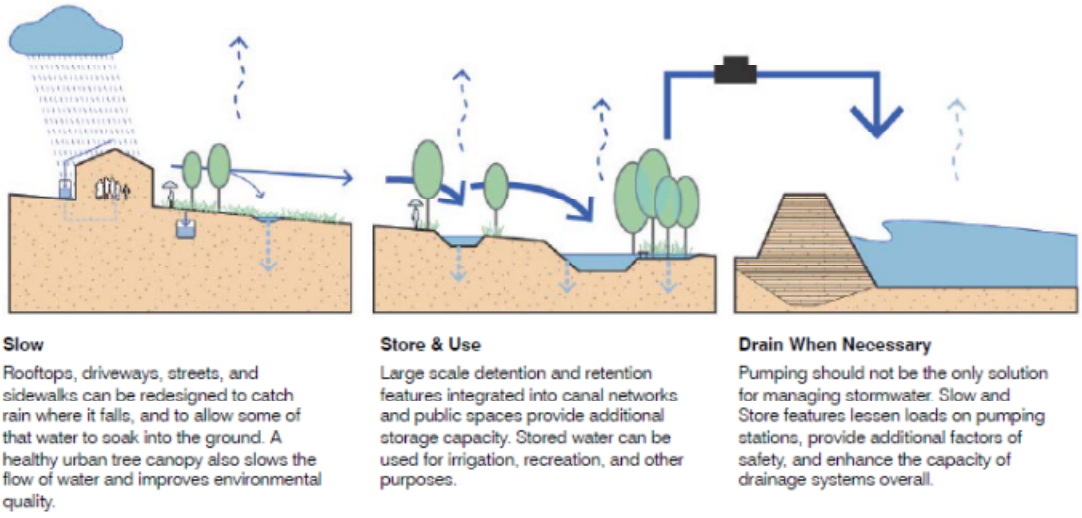

Figure 3: Greater New Orleans Water Plan's slow, store, use and drain when necessary methodology for stormwater management (Waggonner & Ball Architects, 2013a).

The History of Water Management in New Orleans

The Greater New Orleans region has always had a close connection to its abundant water resources. The city is located at the mouth of the Mississippi River as it flows southward toward the Gulf of Mexico (Figure 4 below), and the marshy geography of the coast that surrounds the city is "as much a part of the sea as it is of the land" (Freudenburg et al., 2009). Though this geography made development difficult due to swampy soils and poor drainage, the city and its surroundings were settled as an urban center due to the economic importance of the Port of New Orleans to the national economy (Freudenburg et al., 2009). In order to support the economic activity and in-migration resulting from the importance of the Port of New Orleans, the wetlands of the region became fractured from infrastructure as well as constant drainage and pumping. These embargoed wetlands have created an unique situation in the Greater New Orleans region in that such fragmentation has severely constricted the ecosystem functioning of the wetlands in the region. Thus, the history of the New Orleans region is very much that of a city's relationship to water, and the water management practices implemented through human

settlement have had drastic effects on the overall ecology of the water ecosystems within which the region is located (Freudenburg et al., 2009).

Figure 4: Geographic location of New Orleans in its proximity to the Mississippi River and the Gulf of Mexico (USGS, 2014).

In order to support transportation and navigational activity, some of the first water-related infrastructure created in the city was the dredging of canals (Freudenburg et al., 2009). Later, as more settlers came into the area and drainage technology improved, cypress swamps in areas lower than the high ground ridges were drained and settled with development (Freudenburg et al., 2009). Because this settlement took place in low lying areas, levees were constructed around the region to prevent flooding from external forces, and extensive drainage and pumping systems were put into place to remove stormwater as quickly as possible before it caused damage (Waggonner & Ball, 2013a). This heavy reliance upon a structural system of levees and stormwater drainage continues in the Greater New Orleans region today (Waggonner & Ball, 2013a).

The location of the city in a coastal, subtropical zone provides the region with significantly more rainfall than other American cities of similar size (Waggonner & Ball, 2013a). In the metro region alone, an average of 60 inches of rain fall per year (Waggonner & Ball, 2013a). In addition to this extensive amount of rainfall, the pumping of stormwater from developed areas within the region has contributed

to the demise of organic elements within the area's soil, causing subsidence. This subsidence has created a below sea level bowl effect in the region inside the levee structures, that fills quickly when the region experiences heavy rainfall (Waggonner & Ball, 2013a). Thus, the pumping and drainage system of the Greater New Orleans is not always able to operate at the capacity necessary to mitigate extensive amounts of stormwater, and flooding has become a serious hazard in the region (Waggonner & Ball, 2013a). The Urban Water Plan study states that the sinking ground, the amount of impervious cover in the region, the limited operational capacity of the current stormwater system, and the risk of storm surge the region experiences all contributes to expensive flooding and structural damage due to stomwater and subsidence (Waggonner & Ball, 2013a). These hazard risks, in addition to limited access to the region's ample water features for recreation and development formulate the justification for a new, green, sustainable stormwater system to be implemented in the Greater New Orleans region, as has been proposed by Waggonner & Ball Architects and GNO, Inc. in the Urban Water Plan (2013a).

Innovative Green Infrastructure for Greater New Orleans

The Greater New Orleans Urban Water Plan endeavors to revolutionize traditional stormwater management in the Greater New Orleans region through green infrastructural retrofits that follow the Dutch model of slowing, storing, using and pumping stormwater only when necessary (Waggonner & Ball, 2013a). The plan claims that conducting stormwater management in this way would circulate surface water, recharge groundwater, rely upon ecosystem services to infiltrate rainfall, and provide access to water-based ecosystems by the citizens of the region (Waggonner & Ball, 2013a).

The proposed stormwater system outlined in the Urban Water Plan follows a Dutch model for water management due to the collaborative relationship cultivated between New Orleans architect and Urban Water Plan creator David Waggonner and Dutch water engineers. This relationship facilitated the Dutch Dialogues workshops that served as brainstorming sessions regarding ways in which New Orleans could begin to support sustainable stormwater management similar to what has been done in the

Netherlands to combat flooding risk (Meyer et al., 2009). Though the two regions must deal with significant flooding hazards and the increasing effects of sea level rise from climate change, they are very different in geography, in hydrology and in culture (Meyer et al., 2009). Thus, the green infrastructure supported in the Urban Water Plan has been created using the Dutch model of stormwater management as its design foundation, and has been modified in order to suit the hydrologic and geographic context of Greater New Orleans.

The Urban Water Plan outlines a process for slowing, storing and using, and draining stormwater through the use of green infrastructural retrofits into the urban environment. Such infrastructure will allow natural water-based ecosystems to function in an organic capacity to infiltrate rainfall and reduce damaging runoff in the region. The "slowing" component of the methodology is proposed to be achieved in the plan through the retrofitting of rooftops, yards, impervious pavement in driveways, parking lots and streets to vegetated green infrastructural elements that capture and evapotranspirate rainfall (Waggonner & Ball, 2013a). The "storing" and "using" method of integrated water management is exemplified in the plan through green infrastructure design that would store excess stormwater, help it absorb into the ground and be used to recharge regional groundwater reserves (Waggonner & Ball, 2013a). The "draining" component of the methodology is intended to only be used when incidences of system overflow takes place. The plan claims that the slow, store and use methodology will severely reduce the need to pump stormwater through drainage systems since the amount of pervious material that would be created through green infrastructure to facilitate this methodology would sufficiently capture rainfall before it could become stormwater (Waggonner & Ball, 2013a). This green infrastructure methodology is supported in the plan as a way in which to avoid gray stormwater infrastructure pumps that are expensive to the municipality in their operation and maintenance. Additionally, the switch from traditional gray infrastructure to green infrastructure is advocated as a way

to reduce the risk to flooding from stormwater runoff in Greater New Orleans (Waggonner & Ball, 2013a).

In order to implement the "slow, store and use, and drain only when necessary" methodology supported in the plan, a series of large scale and small scale green retrofits to existing stormwater infrastructure are proposed. The large retrofits recommended for traditional stormwater infrastructure have to do with splitting the existing drainage canals and constructing new pump stations to lessen the burden of runoff that flows into Lake Pontchartrain with the current system (Waggonner & Ball, 2013a). The plan claims that splitting the drainage canals to distribute stormwater more efficiently would also allow for increased access to water features in the urban environment due to the lessened need for high floodwalls in the existing canals to contain large amounts of stormwater (Waggonner & Ball, 2013a). An additional large scale retrofit is proposed in the plan that would retrofit both the New Orleans East and St. Bernard stormwater catchment basins to divert stormwater more appropriately into strategic parklands as opposed to the lake (Waggonner & Ball, 2013a). The plan states that doing so would provide more opportunity for the region's existing water features to infiltrate stormwater, and recharge crucial groundwater (Waggonner & Ball, 2013a).

To slow the amount of rainfall turning into stormwater runoff, small scale retrofits are proposed in the Urban Water Plan as a way to reduce the amount of impervious cover within the region (Waggonner & Ball, 2013a). Pervious paving, rain gardens, bioswales, and retention basins are the plan's suggested green infrastructure improvements for privately-owned property that would contribute to overall stormwater management (Waggonner & Ball, 2013a). Pervious pavement, curb cuts, curb extensions and water-storing subsurface chambers are also encouraged as small scale municipal urban stormwater retrofits along the streets of Greater New Orleans (Waggonner & Ball, 2013a).

Facilitating the construction and retrofitting of new and existing parklands throughout the area as strategic stormwater storage basins are suggested in the plan as potential overflow basins needed for

stormwater storage (Waggonner & Ball, 2013a). Additionally, the plan suggests that strategic wetlands be created and cultivated in these parks in order to filter stormwater through ecosystem services (Waggonner & Ball, 2013a). The plan states that these features will support the "slow, store and use" methodology as well as provide access to water features for communities in the region. Related to this, the plan suggests that projects following the proposed methodology should be implemented within municipal waterfront development zones so that high density, multi-use development can take place alongside water features (Waggonner & Ball, 2013a). The plan claims that doing so would integrate urban features among the constructed green infrastructure and contribute to an urban water identity (Waggonner & Ball, 2013a).

In order to implement and monitor these retrofits for the "slowing, storing, using and draining" of stormwater, the plan recommends the creation of regional monitoring networks in order to coordinate the projects among the three parishes (Waggonner & Ball, 2013a). It is projected that such regional monitoring will make it easier for the plan's projects to be implemented and updated since these projects are developed based on water districts that represent sub-watershed scale stormwater management, as opposed to areas within the political boundaries of each parish (Waggonner & Ball, 2013a). Each water district in the plan has coordinating green infrastructure designs specific to the area. The plan suggests that the creation of water districts can facilitate sub-regional identities around their corresponding water features, and will engage stakeholders within each district in stormwater management differently. Eight water districts and corresponding projects are described in the plan that focus on strategic green infrastructure implementation designed to follow the flow of water within the district (Waggonner & Ball, 2013a). The plan claims that these water districts, though they cross neighborhood and parish lines, will facilitate urban identities within each of these areas that will enrich each place and citizen's current urban identity (Waggonner & Ball, 2013a).

Chapter V

Sustainability in the Urban Water Plan

The Greater New Orleans Urban Water Plan, through its designs for green infrastructure, claims that a new stormwater system will facilitate a sustainable Greater New Orleans region. Since the Urban Water Plan endeavors to reimagine municipal stormwater infrastructure towards sustainability, the assertions made in the plan regarding its potential to foster sustainability will be analyzed using the theory described by Campbell and applied in this thesis in terms of stormwater management (2012). Such an analysis will attempt to answer the initial research question of this thesis: Does the Greater New Orleans Urban Water Plan promote sustainability? Therefore, the outline of sustainability in the plan that follows is broken down by the priorities of environmental, economic and equity planning that comprises sustainable stormwater planning previously defined in the literature review above. Within the discussion of the plan's pursuit of each sustainability priority, summaries of prescriptions given in the plan as to how to achieve these priorities are included.

Claims of Environmental Protection in the Urban Water Plan

The Urban Water Plan endeavors to achieve the first priority of Campbell's concept of sustainable development through the protection of the watershed within which the Greater New Orleans region is located with green infrastructure that would strengthen "the health of regional wetlands, which are natural buffer zones that reduce the velocity and height of hurricane-driven storm surge and winds" (Campbell, 2012; Waggonner & Ball, 2013a). An acknowledgement of the connection between healthy wetland ecosystems services as outlined by Costanza et al. and the strength of the land and communities in proximity to them is given as justification for this claim (Costanza et al, 1997; Waggonner & Ball, 2013a). The plan's small and large scale retrofit projects are designed to improve the region's ability to improve water quality due to the reduction of stormwater runoff expected from green infrastructure (Waggonner & Ball, 2013a: 28). Additionally, the plan states that the green infrastructure

projects would re-vegetate the watershed, and help freshwater flow into constructed and restored wetlands (Waggonner & Ball, 2013a). Because the plan would guide the management of stormwater, surface water, and groundwater symbiotically, the projects suggested are intended to create a "greener and cooler environment" that stimulates overall ecological health (Waggonner & Ball, 2013a).

Environmental protection through the green infrastructure projects of the Urban Water Plan is described in the *Implementation* section of the plan. Language in the *Implementation* section recognizes the need for non-structural planning regulation as outlined by Schwab for the purpose of green infrastructure promotion in that it states that the Urban Plan coordinates with the City of New Orleans' "Plan for the 21st Century" comprehensive master plan (Schwab, 2010: Waggonner & Ball, 2013b). The Urban Water Plan states that the City's master plan addresses the need for innovative water management in order to reduce the risk that the hazards of flooding, groundwater pollution and subsidence pose to the region's communities (Waggonner & Ball, 2013b). The plan speaks further of the need for non-structural regulation in Jefferson and St. Bernard in helping to promote ecosystem health by stating that such regulation is "the starting point for creating a regulatory and land use context that asks property owners to take responsibility for the runoff from their properties, and gives systems managers and municipalities the tools that are necessary to regulate runoff" (Schwab, 2010; Waggonner & Ball, 2013a). By making these statements regarding coordination of environmental protection through government intervention, the Urban Water Plan addresses the need for land use regulations to guide the implementation of green infrastructure in the Greater New Orleans region and protect the environment outlined by Schwab and Berke et al. (2010; 2009).

In addition to connecting environmental protection in the plan to existing comprehensive planning, the Urban Water Plan makes several policy recommendations in order to strengthen potential implementation. One recommendation made by the plan to assist implementation is for the calculation and monitoring of the quantity and quality of stormwater to be conducted before, during and after

implementation of the plan's projects (Waggonner & Ball, 2013b). In making this recommendation, the plan thus requests land use classification calculations of impervious cover and its relationship to stormwater runoff be conducted at the municipal level as suggested by Berke et al. (2006). Additionally, the plan calls for the creation and enforcement of a stormwater retention standard into local zoning ordinances and building permitting processes to encourage the construction of green infrastructure on public and private property (Waggonner & Ball, 2013b). The Urban Water Plan further discusses the use of regulations for the protection of the environment as it suggests developing and enforcing design guidelines in the zoning and building codes of the region to reduce impervious cover on new public and private development (Schwab, 2010; Waggonner & Ball, 2013b).

Claims of Economic Development in the Urban Water Plan

The Urban Water Plan makes claims of promoting economic development through sustainable stormwater management throughout the plan's sections by referring to the region's ample water resources as an asset (Waggonner & Ball, 2013a). The plan makes an outright assertion to economic opportunity facilitated by green infrastructure design by stating that such design will create "stronger regional identity and competitiveness, construction jobs, reinvestment in disadvantaged neighborhoods, revitalization of commercial areas, and a global leadership role in water industries, research, development, planning, and design for resiliency" (Waggonner & Ball, 2013a). As advocated for by Leigh & Blakely, the plan stresses that the potential for regional economic growth was a "key criteria applied in prioritizing and designing each of the proposed projects", and that opportunity for economic development from green infrastructure serves as justification for the implementation of the plan itself (2013; Waggonner & Ball, 2013a). The Urban Water Plan additionally stresses that the commitment to green infrastructure projects by the Greater New Orleans region are "smart investments…fundamental to the economic and ecological wellbeing" of the region (Waggonner & Ball, 2013a). More specifically, a claim of sustainability through economic development as outlined by Campbell is made regarding

individual infrastructural projects in that the plan states that each project will be "more than just an investment in infrastructure, and must serve instead as a long-term development opportunity that creates value for all stakeholders from each proposed retrofit" (Campbell, 2012; Waggonner & Ball, 2013a).

The Urban Water Plan, in its attempt to promote economic investment and opportunity through a "water environment that inspires market confidence and innovation" provides some specific information as to the precise economic benefits expected from the green infrastructure by the plan's promoters and authors (Waggonner & Ball, 2013b). Detailed economic benefits stemming from green infrastructure described in the plan are "job creation, reduced flooding and subsidence damage, reduced insurance premiums, and increased property values for a total economic benefit of $22.3 billion" (Waggonner & Ball, 2013b). Specific to property values alone, the plan claims that the proposed water management projects will create an increase in property values within 41,500 properties within 200 meters of each project in the region by $183 million over 50 years of implementation (Waggonner & Ball, 2013a). The plan also highlights the benefits of green infrastructure to the economy by outlining the costs projected to be incurred by municipalities and property owners in the region should nothing be done to update the stormwater system as it currently stands. Additionally, the increased costs of flood insurance, damage to structures due to worsening subsidence, the projected cost of maintaining, repairing and operating gray infrastructure and the loss of a tax base should these issues deter investment are listed and juxtaposed with the economic benefits outlined in the plan to provide justification for the potential for economic savings and growth that green infrastructure can provide for the region (Waggonner & Ball, 2013b).

Ways in which to ensure that economic stability and growth takes place in relationship to the green infrastructure proposed in the plan are provided in the *Vision* and *Implementation* documents of the plan as well. To begin, similar to the research of Valderamma et al., the enactment of municipal

incentives and penalties for property owners who implement or refuse to implement green infrastructure design are suggested as a way to encourage holistic water management (2013; Waggonner & Ball, 2013a). More specifically, the plan supports the implementation of a rate increase by the Sewerage and Water Board of New Orleans to help the municipality fund green infrastructure renovation and attract investment to the region (Waggonner & Ball, 2013a). Following the same logic as that put forth by Valderamma et al., a reduction in this fee is suggested as a way to encourage green infrastructure in the region in individual cases only after ratepayers implement specified stormwater reduction measures (2013; Waggonner & Ball, 2013b). Additional ways proposed to fund and incentivize green infrastructure development for economic growth are listed in the plan as: the creation of special tax assessment districts to fund infrastructure beyond the municipal capital improvements budget; the implementation of rebates, fee reductions or density bonuses for private developers who implement green infrastructure and thus reduce impervious cover and stormwater runoff; the sale and purchase of stormwater credits on a private market; and the construction contracts for public green infrastructure development to be implemented by private firms (Waggonner & Ball, 2013a; Waggonner & Ball, 2013b). Such municipal programming, as stated in the plan, "would directly and indirectly finance projects that incorporate or exceed certain stormwater requirements" and would thus sustain economic investment and court new growth through the creation of a private market for green infrastructure in the region, similar to that which has been researched by Valderramma et al. (2013; Waggonner & Ball, 2013b).

Claims of Social Equity in the Urban Water Plan

The Urban Water Plan quantifies Campbell's priority of equity in sustainability through an enhanced quality of life achieved through "improved tree cover and streetscapes, lower ambient air temperatures, improved water and air quality, robust park and wetland ecosystems, and waterways as multi-functional open space and recreational networks" (Campbell, 2012; Waggonner & Ball, 2013a).

The plan also asserts that green infrastructure will enhance quality of life for communities in the region because integrated water management would speed up the process of "reconnect[ing] communities with water and with each other to enhance the prospects and well being of all" (Waggonner & Ball, 2013b). The conversion of urban areas into green infrastructure will create increased opportunity for recreation among citizens, which the plan states will "inject vibrancy into urban and suburban corridors and sites, reconnect[ing] neighborhoods and people" (Waggonner & Ball, 2013b). Additionally, the plan states that quality of life, and thus equity, will be enhanced by green infrastructure through the decreased occurrence of disruptions from environmental hazards exacerbated by gray infrastructure, yet no spatial identification of where less disruptions would take place are listed(Campbell, 2012; Waggonner & Ball, 2013b). The plan claims that less hazard events can positively impact the community because important customs, ways of life and the cultural economy of the region will be protected and sustained (Waggonner & Ball, 2013b).

As further proof of sustainability achieved through the priority of social equity, the plan claims that public inclusion and representation in the planning process have been practiced due to the strong network of stakeholders that includes community members, civic leaders, politicians and water management professions already in support of sustainable water management in the region, and that their participation in the outreach meetings held to disseminate the plan and discuss sustainable water management is evidence of public consensus around the plan's innovative ideas (Campbell, 20132; Arnstein, 1969; Waggonner & Ball, 2013a). In addition to current support, the plan states that inclusion and public participation was achieved in the planning process through the community engagement strategy provided in the *Implementation* section of the plan (Waggonner & Ball, 2013b). This strategy was divided into three phases that endeavored to create "broad and informed community engagement" for the integrated approach to water management designed by the plan (Waggonner & Ball, 2013b). Phase I of the strategy involved meetings with community leaders in order to provide them with

information regarding the water plan's proposed activities to later disseminate to their communities (Waggonner & Ball, 2013b). Phase II of the strategy included design workshops to demonstrate the projects created for the specific water districts built into the plan (Waggonner & Ball, 2013b). The audience for these workshops was key stakeholders, who were encouraged to provide input on the selection of demonstration projects for the plan (Waggonner & Ball, 2013b). Lastly, Phase III of the community engagement strategy was conducted near the completion of the Urban Water Plan to present the designs to identified stakeholders throughout the region in order to gain political support of the plan (Waggonner & Ball, 2013b). In addition to the community engagement strategy, the plan also states that "ongoing efforts over the last two years and throughout the project area to communicate regularly with policy makers, system managers, key stakeholders, potential investors, real estate professional and planning, design and engineering professionals" have been made in order to create an inclusive, equitable planning process in the development of the Urban Water Plan (Waggonner & Ball, 2013b).

In order to achieve further participation and the equitable distribution of water resources, several additional approaches are outlined in the Urban Water Plan for the future. In order to ensure equitable distribution of resources, the plan states that citizens should be provided "with assistance …towards implementation of stormwater projects" through the provision of tools, manuals and volunteer assistance to aid them in constructing small scale retrofits on private property (Waggonner & Ball, 2013b). Skills training programs are suggested, and funding for their provision is encouraged in the plan to train young people in the community for employment in potential water management projects, providing a level of citizen power as described by Arnstein and thus distributing more equally the jobs projected to be created through economic development (1969; Waggonner & Ball, 2013b).

To facilitate public participation in implementation, enhanced "water literacy" programming is suggested for K-12 schools, as well as in higher education, to help young people understand the role

that water management plays in sustainable development and create community support of the integrated water management purposed in the plan (Waggonner & Ball, 2013b). Such an initiative increases the amount of citizen engagement possible in the management of resources and thus complies with literature put forth by Arnstein and Berkes (1969; 2009). Additionally, the plan encourages that promoters of the plan use the momentum already documented at public meetings regarding planned projects as well as highly visible demonstration projects within communities to facilitate increased education among community members about the plan and to create public buy-in of proposed green infrastructure (Waggonner & Ball, 2013b). The plan also suggests that equity and inclusion in Berkes' co-management technique of resource management can take place though training for citizens on groundwater level monitoring and the utilization of social media to report groundwater levels to the larger community (2009; Waggonner & Ball, 2013b).

Summary of Sustainability in the Urban Water Plan

Through the identification of language regarding Campbell's priorities of environmental protection, economic development and social equity in the Urban Water Plan, it is evidenced that the plan does attempt to promote sustainability in its design. Yet, further analysis of these statements must be conducted in order to understand their strengths and weaknesses and to suggest recommendations for improvement of the plan and its process prior to implementation. Using the language of the plan regarding sustainable stormwater management as a foundation for evaluation, the theory and best practices of urban planning can be useful for plan revision and the promotion of a more equitable development process.

Chapter VI

Improving the Urban Water Plan for Implementation

The Urban Water Plan has been designed to be "a living document created to inspire and guide long-range planning and strategic investments for the next fifty years" in regards to integrated stormwater management in the New Orleans region (Waggonner & Ball, 2013a). The fact that the plan has been designed to be flexible to new ideas provides a strategic research opportunity to ensure that the policies and strategies that make up the plan are most representative of the needs of the environment, economy and communities of the Greater New Orleans region in terms of sustainable development. Because the plan attempts to promote the three priorities of sustainable development through green infrastructure, the tensions that Campbell describes arise when planning for each of these priorities are inherent in the Urban Water Plan (2012). Applying planning research and best practices such as those from Philadelphia and Portland that outline prescriptions as to how to mitigate these tensions in sustainable development to the conflicts that arise in attempts to attain each of the goals of sustainable stormwater management in the plan can help to make it more politically palatable and thus improve potential implementation (2009; 2010). By employing planning literature and practice regarding the negotiation of the tensions of sustainable development in the section that follows I will endeavor to resolve the second research question of this thesis: What best practices and literature from urban planning could be utilized to improve the potential for the plan to facilitate sustainability in the Greater New Orleans region?

Negotiating the Property Conflict in the Urban Water Plan

The Urban Water Plan makes a significant attempt to ease the tension between protecting the water rich environment created and preserved by its green infrastructure projects and the preservation of economic growth (Campbell, 2012). The plan attempts to broker compromise between government regulation and private interest by stressing the important role that Valderrama et al. state private

interest must play in holistic water management by stating “no public entity can solve all of the issues the region faces without the cooperation of property owners, businesses, and institutions” (2013; Waggonner & Ball, 2013a).

The plan acknowledges Campbell’s argument that private interests may be resistant to any potential environmental regulation, and suggests that a compromise can be achieved in the property conflict through the promotion of the economic benefits that healthy water resources can provide among private interest (Costanza et al.; Waggonner & Ball, 2013a). The Urban Water Plan states that its projects would “build upon existing flood protection systems by broadening the concept of ‘multiple lines of defense’ to include urban water management” , thus making green infrastructure attractive to private interest since the services that it provides through constructed water-based ecosystems mitigate potential damages to property and communities from flood damage as outlined by Costanza et al. (1997; Waggonner & Ball, 2013a: 26).

Yet, the ecosystem services that Costanza et al. describe in their work are not wholly applicable to the context of the Greater New Orleans region due to the fragmented nature of the larger wetland ecosystem of the area (YEAR; Freudenburg et al., 2009). Wetlands as natural containment and filtering systems for stormwater retention can be a powerful tool, as evidenced by the work done in Portland, yet as Freudenburg et al. state, the water-based ecosystems of the New Orleans region have been heavily embargoed with infrastructure, making their ability to adequately provide ecosystem services weaker than if they were undisturbed (2009). Thus, the theory purposed by Costanza et al. regarding ecosystem services and their benefits as promoted in the Urban Water Plan’s designs for green infrastructure are not completely congruent, and the plan’s design to use green infrastructure within an embargoed wetland ecosystem remains an area of weakness in the plan’s potential to foster sustainability in the long term (1997).

While the Urban Water Plan makes a substantial effort to negotiate the property conflict in its plan documents, in order to make the negotiation of the property conflict easier prior to implementation, better outreach should be conducted with the business community regarding the necessity of sustainable stormwater management to facilitate the understanding that refusing to implement green infrastructure in the Greater New Orleans area will be detrimental to social, environmental and economic interests. The plan has a strong foundation from which to conduct such education in the section entitled "Cost of Inaction" within the *Implementation* portion of the plan (Waggonner & Ball, 2013b). In this section, the plan provides detailed information regarding the hazard risks to flooding and subsidence present in the area due to current development patterns, as well as information regarding how damage from these risks has and will continue to cost citizens, municipal governments and business large amounts of savings and profit (Waggonner & Ball, 2013b). The information in this section can be a strong tool to mitigate tensions between changes in the regulatory framework necessary to institute green infrastructure and private interests resistant to restrictions on uses of their property and economic gain. Such a tool should be strengthened and made more readily available by environmental planners for distribution among the business community and the neighborhoods of the region in order to build public support and buy-in of the plan's projects.

Negotiating the Resource Conflict in the Urban Water Plan

Just as with the attempts to mitigate the property conflict, the Urban Water Plan makes a considerable effort to mediate the tensions Campbell states take place between restrictions on the environment and the potential for continued and new economic growth stimulated by the resource conflict (2012). Input from the business community on how to facilitate growth through green infrastructure is highly valued in the plan's documents, with statements like the following showing commitment to economic values: "Because business owners depend on functioning infrastructure and an environment that does not exact excessively high costs, they will play an important role in shaping

discourse around public investments" in green infrastructure (Waggonner & Ball, 2013a). The plan states that the inclusion of the business community in the decisions made regarding implementation will "help to spur new thinking and foster innovation" in relationship to any economic opportunities possible from sustainable stormwater management (Waggonner & Ball, 2013a).

Commitment to the inclusion of private business interest into the planning and implementation processes of the Urban Water Plan is manifest through the extensive description of funding and investment attraction strategies included in the "Financing Tools" section of the *Implementation* strategy of the plan (Waggonner & Ball, 2013b). Within this section, several strategies for creating a private market for green infrastructure are eluded to that relate to Valderamma et al.'s research regarding strategies for stimulating private capital investment in sustainability (2013). More specifically, the plan states that Valderamma et al.'s research regarding pay-for-performance finance, installation financing, and the trading of ecosystem services that culminate in reduced stormwater runoff could attract private investment to the region and thus achieve both the economic and environmental priorities of sustainability (2013; Waggonner & Ball, 2013b). Through making policy recommendations that encourage creative thinking about how to stimulate private investment in green infrastructure such as those put forth by Valderamma et al., the Urban Water Plan considers the resource conflict of sustainable development.

Yet, in order to operationalize such a market and successfully broker compromise, the Urban Water Plan could benefit more strongly from current economic planning research that describes in extensive detail how to create the necessary policy structure within which a private market for economic opportunity around green infrastructure could be created and cultivated. For example, as outlined by Valderrama et al., stressing the implementation of a public-private partnership implementation methodology at the municipal level such as the availability payment model could provide guidelines for how to secure and manage pay-for-performance private contracts for the

construction of the green infrastructure projects outlined in the plan (Valderrama et al., 2013). Additionally, as suggested by Valderamma et al., strengthening and applying enabling legislation at the state level to guide the process of public-private partnerships for municipal infrastructure should be conducted in order to assist public authorities in attempts to negotiate procurement contracts (2013). Such legislation would be beneficial to the creation of a private market for public green infrastructure in that it would provide permission for the combination of government funds with private funds, allow for long-term franchise leases or concessions, allow public sector agencies to hire their own technical consultants for implementation as well as to outsource for the operation and management of green infrastructure (Valderamma et al., 2013). By creating a policy framework as suggested in planning literature, implementation of the Urban Water Plan's planned projects could cultivate private interest, and better stimulate an urban economy around sustainable infrastructure.

Negotiating the Development Conflict in the Urban Water Plan

The Urban Water Plan's attempts to moderate the development conflict of sustainable development provide the biggest opportunity for improvement prior to implementation. Urban planning theory and research regarding the ways in which to foster participation in the decision-making processes for public infrastructure and its management become relevant, needed frameworks to guide plan implementation and create crucial community buy-in of the planned projects (Arnstein, 1969; Berkes, 2009). The community engagement plan and proposed social benefits outlined in the Urban Water Plan are a narrow attempt at public participation and equitable distribution of resources, and in order to make the plan more politically palatable and to promote just development, stronger strategy for inclusion in the planning and implementation processes of sustainable stormwater management is paramount to feasibility.

The plan made an initial effort to broker the development conflict of sustainability through outreach conducted during the plan development process. As stated above, the outreach conducted

over the two year study period involved presentations to grasstops leaders, workshops for stakeholders regarding design and management, and community meetings to disseminate the plan for community feedback (Waggonner & Ball, 2013b). As Arnstein argues, providing information to community leaders to take back to their communities and only holding a few meetings for community member input does not activate the citizen power necessary for community members to be deliberately included in decisions made about their future in terms of public infrastructure (1969). Additionally, management of the water resources preserved and created through the plan's proposed green infrastructure projects is not proposed to be handled collaboratively between institutions, private firms and community members as would be representative of Arnstein's theory of citizen engagement (1969). The plan narrowly mentions the possible inclusion of community members in the management of projects as described by Berkes through the recommended future action to "provide training in groundwater level monitoring" to citizens and have volunteers use social media to communicate groundwater level information to the mass public (Waggonner & Ball, 2013b). Such a thin mention of collaborative management of water resources in the Urban Water Plan does not facilitate the mediation of the development conflict in terms of the equitable distribution of resources necessary for sustainable development (Campbell, 2012).

Therefore, the Urban Water Plan could take much from the lessons of urban planning literature as to how to facilitate equity and inclusion in the planning and implementation process of sustainable stormwater management. Following the methodology of co-management for planning put forth by Berkes, community oversight of potential implementation and later monitoring and evaluation of the plans projects would make holistic green infrastructure in the Greater New Orleans region more feasible in the long run (2009). Co-management would create an institutional framework comprised of community members, stakeholders, and local government that would ensure representative implementation of planned projects over the long term and ensure that the design of green

infrastructure projects ensured safety among communities at high risk to water-related hazards (Berkes, 2009). Additionally, co-management could help to drive the planning and monitoring process of green infrastructure development so that the benefits from the planned projects of the Urban Water Plan are gauged for equity, and not solely evidenced in increased property values.

Frameworks regarding public participation and co-management are additionally applicable to the Urban Water Plan prior to implementation in order to ensure that the economic benefits of private participation in a green infrastructure market are distributed fairly among the communities of the proposed project area and don't contribute to inequality or gentrification among neighborhoods. Using economic planning literature as a guide for equitable development, the Urban Water Plan should ensure that community -valued performance standards are built into public-private contracts for the provision of green infrastructure improvement (Bartik, 2007; Weber, 2007). Facilitating discussion between plan promoters, planners and community members through a participatory process can ensure that private provision of infrastructure contributes to the design standards necessary to ensure that green infrastructure implemented contributes to a safer environment from water-related hazards and not just a beautiful landscape (Bartik, 2007).

Additionally, community informed performance standards built into contracts for public-private collaboration in infrastructure construction and management are crucial in order to safeguard taxpayer dollars used to pay private firms (Weber, 2007). Related to this and as stated by Bartik and Weber, the development of stipulations regarding equal consideration of local firms in private contracts for implementation and monitoring, as well as local employment guarantees and wage standards must be an integral part of the participatory planning process for sustainable infrastructure and the courting of private investment (Bartik, 2007; Weber, 2007).

Summary of Suggestions to Improve the Urban Water Plan

The tensions of sustainable development as described by Scott Campbell can be difficult to overcome as each tension represents deeply held values related to the public interest (2012). Urban planning theory and best practices provide crucial strategies with which to navigate the seemingly divisive nature of sustainable development. In the context of stormwater management in the Urban Water Plan, much can be taken from theory and lessons learned regarding the negotiation of these conflicts in regard to water-based resources and green infrastructure development.

As stated by Costanza et al., ecosystem services provide many benefits both to human and environmental health, yet they can also be a powerful addition to an outreach strategy developed based on the *Cost of Inaction* section of the Urban Water Plan (1997; Waggonner & Ball, 2013b). Providing this information more widely can help to gain community and business buy-in of the plan's projects, and can highlight the unique nature of the wetland ecosystems of the Greater New Orleans region. Such a realization could foster future research into how to negotiate between environmental and economic interests within an ecosystem severely fractured from previous development.

The Urban Water Plan does attempt to negotiate the resource conflict of sustainable development with its suggestions for innovative techniques to foster public-private partnerships in green infrastructure development. Yet, the plan could significantly benefit from economic planning research regarding strategies with which to make such public-private partnerships more feasible. As Valderamma et al. point out, a policy framework is necessary to guide the collaborative process between developers and municipalities, and therefore the plan could be made stronger with the addition of stronger language regarding feasibility (2013).

Lastly, the Greater New Orleans Water Plan must do more to ensure that social equity is encouraged in the plan's process and implementation. Urban planning literature put forth by Arnstein and Berkes regarding participatory planning processes and co-management of resources could inform

the development of a more equitable governance structure for the Urban Water Plan, more equal economic opportunity, and ensure community buy-in of projects (1969; 2009). Additionally, facilitating communities protected from risks must become equally important to the development of real estate and an improved landscape in the plan's process and potential implementation. Urban planning theory and lessons learned from cities such as Philadelphia in the development of equitable processes for watershed management can become useful tools in revising the Urban Water Plan towards truly sustainable development (2009).

Chapter VII

Regional Resilience in the Urban Water Plan

Because the Urban Water Plan is a stormwater management for a tri-parish region along the Gulf of Mexico, it is important to analyze the document in its attempt to coordinate urban stormwater efforts to those of a regional context and with larger coastal management. As stated in the literature review above, planning for regional resilience results in better prospects for sustainability at local levels because regional resilience creates systems and infrastructure less likely to experience extreme impact from strong disturbances such as strong storms, hurricanes, climate change or other external forces (Jabareen, 2013). Thus, through the following analysis of the statements regarding regional resilience in the plan endeavors to answer the third research question of the study: How could a focus on regional resilience in the plan improve sustainability in Greater New Orleans, and the Louisiana coast?

Regional Resilience to Stormwater

Taking the tri-parish regional context within which plan takes place, a hypothetical foundation from which regional resilience thinking can be conducted is proposed in the plan. To begin, the Urban Water Plan suggests a new water management approach "built on a regional basis and according to hydrologic and geologic jurisdictions" rather than political parish boundaries that have little in common with the direction and flow of rainwater and stormwater (Waggonner & Ball, 2013a). The plan provides evidence that such an approach is possible by referencing the Dutch Dialogues collaborative research, and by stating that "the technologies and design solutions that the region needs to respond to…challenges exist already and have been successfully employed by cities with comparable soil and water conditions" (Waggonner & Ball, 2013a). Building upon an understanding of regional risks, of the hydrologic flow of stormwater, and international precedents for regional management, the plan claims will facilitate the creation of a regional watershed management authority to guide implementation of

the plan's green infrastructure with consideration of the regional context within which it is placed (Waggonner & Ball, 2013a).

The regional water management authority proposed in the plan to facilitate watershed resilience would function in several recommended ways. First, the plan suggests that such an authority should work "to implement a policy that requires stormwater management in all transportation projects that involve federal or state funding or approval" (Waggonner & Ball, 2013b). Doing so, the plan claims would help to integrate green infrastructure into the construction of streets and navigational transportation routes, and thus reduce the impact to infrastructure of interregional stormwater runoff between watersheds (Waggonner & Ball, 2013b). Secondly, the regional authority would work to expand an "emerging environmental" industrial sector that would function to "implement integrated water management projects and to ensure that local business and local residents have the capacity skills to do the work" (Waggonner & Ball, 2013b). This function of a regional network is designed to promote resilience among the socio-economic fabric of a larger inter-watershed region. By creating a vibrant business environment and a skilled workforce, the plan claims that the region within which the Urban Water Plan's projects will take place will be more apt to resist overall threats and maintain its daily socio-economic functions (Godschalk, 2003).

Regional Resilience to Seawater

Coastal Louisiana, due mostly to the processes of anthropogenic development, has lost nearly 1,900 square miles of land since the 1930s (CPRA, 2012). If drastic action is not taken to prevent additional loss, another 513 square miles will disappear by the year 2050 (CPRA, 2012). Taking this land loss into consideration of the context of the area of Greater New Orleans for which the Urban Water Plan proposes to revolutionize stormwater management, a focus on regional collaboration on for coastal resilience and local sustainability is important in the planning, implementation and management processes of infrastructure development. Doing so would, as Walker and Salt suggest, provide

collaborative appreciation for the external, coastal forces that threaten sustainability (2006). Thus, a commitment to breaking down the barriers to regional institutional capacity-building must be evident in the Urban Water Plan to ensure coastal resilience that results in local sustainability.

The Urban Water Plan takes into account coastal external threats that directly affect sustainability throughout its documents and uses these external threats to justify the recommendations made as to how to think beyond the local context towards a regional framework. In the plan's *Vision* document, justification for an innovative green infrastructure system in Greater New Orleans is provided by a description of the stress that "growing risk posed by climate change" will pose on traditional stormwater infrastructure due to increased stormwater from temperature change, increased rainfall, coastal land loss and rising seas (Waggonner & Ball, 2013a). Additionally, external threats to sustainability from hurricanes arising in the Gulf of Mexico are mentioned in the plan in regards to the potential rainfall that accompanies such strong weather events so to validate why thinking more broadly about stormwater risk with outdated infrastructure is paramount for future sustainability (Waggonner & Ball, 2013a).

The Urban Water Plan also addresses regional resilience on a coastal scale by linking the Urban Water Plan to "Louisiana's Comprehensive Master Plan for a Sustainable Coast" in the *Implementation* document. To begin the discussion of linkage, the Urban Water Plan states that a significant effort was made to ground the plan "in the recognition that the ongoing collapse of Louisiana's coastal ecosystems poses a survival threat to the entire lower third of the state, including the Greater New Orleans region" as researched and described in "Louisiana's Comprehensive Master Plan for a Sustainable Coast" (CPRA, 2012; Waggonner & Ball, 2013b). The Urban Water Plan additionally acknowledges the statement of the coastal master plan that "community sustainability is dependent on the successful integration of coastal conservation and restoration, structural protection such as levees, and non-structural measures such as elevation, building codes and land use planning" (CPRA, 2012 as stated in Waggonner & Ball, 2013b).

Instituting Resilience

A set of policy recommendations as to how to facilitate resilience thinking in an inter-parish and larger coastal regional context are also provided in the Urban Water Plan in the *Implementation* document as a way to increase overall sustainability of the plan's green infrastructure projects. The plan states that regional cooperation with FEMA, the US Army Corps of Engineers, state and regional stakeholders must take place in order for a comprehensive approach to stormwater management to be achieved at the local level (Waggonnner & Ball, 2013b). This regional cooperation should result in new policy standards and techniques built into ordinances within the region that "respond to this new approach and account for climate change and anticipated sea level rise" (Waggonner & Ball, 2013b).

The Urban Water Plan suggests that regional cooperation to institute resilience will be manifest through the adoption of "a long-term Integrated Water Management Plan with the force of law" that would provide guidelines as to how to implement water management in a regional context (Waggonner & Ball, 2013b). Regulated regional water management would foster the creation and work of a Regional Water Management Authority to oversee inter-parish collaboration with coastal restoration efforts and the integration of water management design into all regional transportation projects (Waggonner & Ball, 2013b). Lastly, the plan recommends that such a legitimate Regional Water Management Authority would ensure funding specifically dedicated to sustainable stormwater management throughout the region, and that these funds are used to forward the goals of the Urban Water Plan (Waggonner & Ball, 2013b).

Summary of Resilience in the Urban Water Plan

With the amount of effort put into discussing regional cooperation for integrated stormwater management in the Urban Water Plan, a focus on resilience as a pathway to sustainability is evident in the plan's documents. As Walker and Salt suggest, the consideration of external factors that affect local development must take place in order to ensure the long term viability of local infrastructure (2006).

The Urban Water Plan, with its repeated mention of the integration of green infrastructure into regional transportation planning takes into account the existing institutional structures that can serve as precedents for the creation and facilitation of a regional water management authority (Waggonner & Ball, 2013b). Relying upon existing institutions that can make the transition from local autonomy in decisions regarding stormwater infrastructure to regional cooperation is a thoughtful step towards gaining the political support necessary to focus on resilience. Yet, the severity of the coastal crisis in Louisiana and the perilous position of the Greater New Orleans region make the urgency with which regional cooperation for resilience, and thus local sustainability, much stronger than that reflected in the documents of the Urban Water Plan (CPRA, 2012). Stronger cooperation between the parishes, and between the parishes and CPRA must take place in order to adequately ensure a resilient region, and sustainable stormwater management in Greater New Orleans.

Chapter VII

Recommendations

The Greater New Orleans Urban Water Plan, while it includes language regarding sustainable development through green stormwater management, it will need revision in order to prioritize the goals of sustainability into its documents and processes over the long term (Campbell, 2012). Best practices and literature from urban planning can serve as a powerful roadmap with which to improve the plan and process for future implementation, and better negotiate the tensions of sustainability over time (Campbell, 2012. The strategies to protect the water-based environment of the Greater New Orleans watershed and to court and sustain economic development related to green infrastructure are well strategized, yet should embrace a more realistic and representative approach from the outset of further progress in order to achieve the community wide commitment necessary for success. The literature reviewed for this thesis focused mostly on the application of better practices in the planning process, and thus the following recommendations need to be considered and implemented systematically prior to and during implementation:

1) A robust outreach and education program, in addition to the water literacy program developed for academic settings, should be created to provide information to Greater New Orleans residents, homeowners, various stakeholders and the business community regarding the valuable services that vibrant ecosystems and thus a healthy environment can provide (Costanza et al., 1997). Included in the programming should be specific information regarding the savings to be expected from functioning ecosystem services (Cohen & Winn, 2007). Making this process as extensive as possible will help with community buy-in for green infrastructure implementation and make the implementation of regulations for the betterment of the environment more politically palatable (Schwab, 2010).

2) A policy framework should be created at the state level to guide the creation of private markets for green infrastructure provision. Enabling legislation and guidelines for a stormwater retention credit market and for pay-for-performance funding of municipal green infrastructure should be created and implemented to legitimize activity in these markets, and to attract new investment to the region (Valderrama et al., 2013).

The community engagement process practiced in during the plan process and the prescriptions in the plan that elude to citizen management of equitably distributed resources fall short of achieving what is necessary for sustainable development (Arnstein, 1969; Berkes, 2009). In order to strengthen the plan and its potential to promote sustainable development prior to implementation, a more robust public participation process must be systematically developed to disseminate the plan's proposed ideas, integrate multi-faceted community viewpoints in to the projects and potential management of the plan and advocate for economic opportunity and safe environments created by green infrastructure to be distributed justly among the region's residents. Such a process should entail:

1) The creation of a citizen advisory board to engage citizen power at the decision-making level (Arnstein, 1969). This board must include members of all neighborhoods potentially affected by the plan. Instead of structuring planned implementation around water districts, as is proposed in the Urban Water Plan, citizens should be engaged at the neighborhood level in order to ensure adequate representation in the processes of planning, implementation and management of projects to ensure comprehensiveness and that safety from hazards is prioritized (Waggonner & Ball, 2013a).
2) The citizen advisory board should be an integral player in the regional water management authority created to guide the Urban Water Plan's projects (Arnstein, 1969). Further, this advisory board should be given decision-making power in the authority, so as to empower

citizens to participate in the infrastructural decisions made for their communities (Berkes, 2005).

3) The citizen advisory board should be included in any decisions made by the regional water management authority or by municipalities regarding the use of public funds for private construction of green infrastructure projects (Berkes, 2009). In doing so, citizens can advocate for more equitable distribution of resources related to water management are equitably distributed through the development of performance standards in contracts (Bartik, 2007; Weber, 2007).

Discussion

In the current context of post-industrial, globalized growth and development, the concepts of sustainable development should be applied to planning for urban areas with urgency in order to preserve our natural resources and create a good quality of life for generations to come. The Greater New Orleans Water Plan has been nationally recognized and should be further commended for its comprehensive, well-researched and visually beautiful approach to green infrastructure design for a revitalized Greater New Orleans region (Waggonner & Ball, 2013a). Yet, the Urban Water Plan is not a plan for sustainability in its current form. Stronger strategies to navigate the property and resource conflicts of sustainable development are needed, and an improved commitment to promoting social equity in the plan is paramount prior to implementation (Campbell, 2012).

Further qualitative research regarding the Greater New Orleans Urban Water Plan should be conducted to better understand the values and interests at play in the planning process and in the development of green infrastructure in the region. A fuller understanding of these values could be beneficial in developing strategies for community buy-in, in that should the interests of the promoters of the plan contrast significantly with those of the public, further revision of the plan's process and projects

should be undertaken. Urban planners could play an essential role in conducting this research due to the focus on the public interest driving the profession and its practice.

Additionally, research regarding the creation of a regional policy framework to guide cooperation among the three parish region and between the region and other institutions is critical at the outset of the plan's process and implementation. Lessons from regional European institutions that have successfully engaged in integrated stormwater management across political boundaries could be of use to the creation of a policy framework to guide a regional water management authority.

Without stronger consideration of the future effects of climate change onto the coastal region of south Louisiana, the Greater New Orleans Water Plan will need much revision. Though the plan is designed to be flexible, stronger modeling and accurate estimates as to the amount of climactic change expected in the region would inform the plan's design and potential implementation. Therefore, research regarding the ways in which climate change effects could affect regional resilience, and thus the feasibility of the Urban Water Plan should be conducted to adequately prepare for the future and modify the document and its projects.

Conclusion

The consideration of vital ecosystem services in the development of an urban stormwater management plan for the Greater New Orleans region is a marked departure from the anthropogenic drainage and pumping gray infrastructure system of 20th century growth (Costanza et al., 1997). As previously stated in this thesis, the region focused on in the Urban Water Plan is a part of the water and sea that envelopes it, and can become a thriving, more beautiful place to reside and make a living through the conversion of structural, traditional drainage to greened spaces, parklands and clean waterways (Freudenburg et al., 2009). Yet, in examining the designs for green infrastructure in the Urban Water Plan, it is important to think about and analyze who gets to live and work in such an improved environment. If communities are not at the decision-making table regarding the creation and

implementation of public infrastructure and regulations to their private property, how can such a Greater New Orleans region provide a better quality of life for all?

Of additional importance to the conceptualization of an improved, greened Greater New Orleans, is the difficulty in accepting the proposed projects of the Urban Water Plan in any real way when one takes into consideration the perilous position of the coast of Louisiana due to land loss and climate change. Whereas the Urban Water Plan does make reference to the need for regional resilience to be considered in planning, implementation and monitoring of the plan's projects, without a stronger commitment to coastal protection by the state of Louisiana in terms of funding restoration projects it is difficult to imagine that the urban area of Greater New Orleans will not be deeply affected by rising, and encroaching seas. A sustainable water management system within the boundaries of levees and floodwalls will be of little importance if Greater New Orleans soon becomes an isolated island in the Gulf of Mexico. Thus, sustainable stormwater management for Greater New Orleans must be seen as a part of a regional system vulnerable to many factors, and in order to implement sustainable infrastructure a more resilient Louisiana coast must be prioritized by policymakers.

Chapter VIII

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